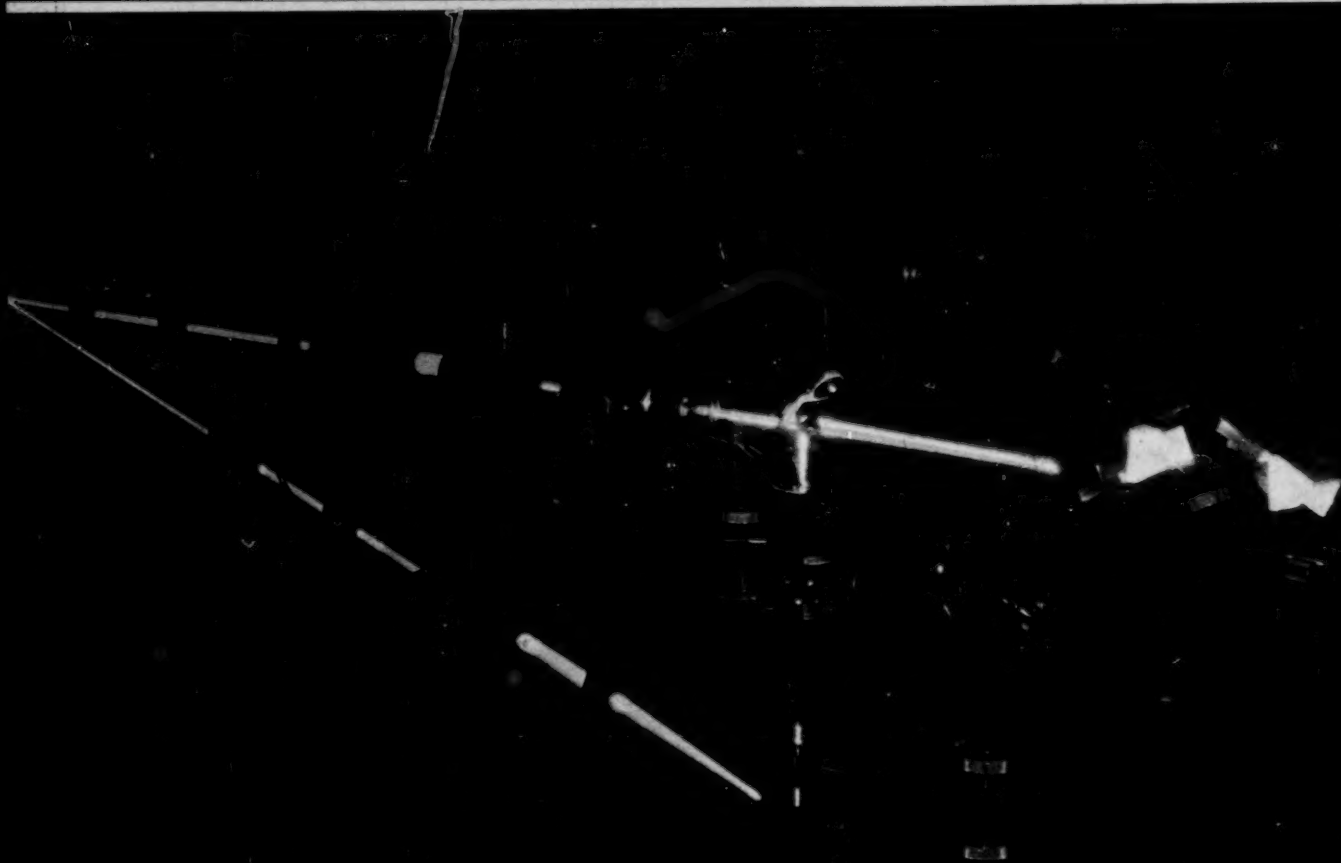


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Chemical &  
Engineering

**NEWS**



## Facts & Figures for Chemical R&D

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# Chemical & Engineering

# NEWS

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## News of the Week

- **Second-quarter earnings** of U.S. chemical companies are down an average of 18% from the same period last year. **Page 10**
- **U.S. yachts contending for the America's Cup** will carry sails made with Mylar polyester film. **Page 11**
- **As much as 20% of U.S. energy needs** could be met by biomass by the end of the century, OTA predicts. **Page 11**
- **EPA pesticides office** should set up priority plans to tackle compounds that may pose greatest risks, NRC panel says. **Page 12**
- **Clinical testing of insulin** produced by bacteria is being carried out by British subsidiary of Eli Lilly & Co. **Page 12**
- **Two programs to study ethical dimensions** of science, engineering, and medicine will be sponsored by NSF and the National Endowment for the Humanities. **Page 12**

## Business

- **Demand for plastics drops sharply**—spring sales lagged behind production, resulting in decreased plant use and steep decline in profits. **Page 16**

## International

- **World survey of company annual reports** finds wide variation in quality of data and concludes international accounting standards are needed. **Page 18**

## Government

- **Council on Environmental Quality** issues report on the global environment in the year 2000: outlook grim unless immediate remedial action taken. **Page 21**

## Technology

- **Revived Dynacracking process** to upgrade heavy crude oils produces distillates and naphtha or fuel gases using three-zone fluidized-bed reactor. **Page 24**
- **Use of natural gas hydrates** as an energy resource will be studied in a two-part project of the Gas Research Institute. **Page 24**
- **Open-cycle OTEC system** will yield distilled water as a by-product of electricity generation, developer says. **Page 28**
- **Large-diameter polyethylene piping** for sewer system, connected by gasketed joints, cuts costs substantially. **Page 28**
- **Chemical reactor that uses membranes** to separate and enrich reaction products as well as support the catalyst designed by University of Pennsylvania/GE team. **Page 35**

## Special Report

**Facts & Figures for Chemical R&D** gives broad view of overall U.S. R&D effort plus detailed picture of funding by the federal government and by industry, how universities fare. **Page 37**

# CHEMICAL EARNINGS DROP IN SECOND QUARTER

U.S. chemical companies weren't kidding when they warned late in the second quarter that earnings had been hit hard (C&EN, June 30, page 4). With a few exceptions, leading chemical producers have reported mild to severe drops in earnings from second-quarter 1979. Some have even reported sales declines from last year.

Overall, results to date from 25 of the 40 chemical companies in C&EN's quarterly earnings survey show that earnings are down an average of 18% in the second quarter from a year ago on a 6% gain in sales. That's quite a reverse from the first quarter, when the year-to-year comparisons showed average earnings still up 31% and sales up 21%.

The earnings decline in the second quarter leaves the chemical industry barely above a flat performance for

first-half 1980. Through the first six months, average earnings for the 25 companies reporting so far are now just 2% ahead of 1979, and sales are up 12%.

Needless to say, profit margins have fallen. For the second quarter combined after-tax profit margin on sales for the 25 companies was 5.4% compared to 7.0% in second-quarter 1979. For first-half 1980, combined profit margin for these companies has slipped to 6.4% from 7.0% in 1979.

The earnings range among companies has moved way down from the heights of the first quarter. In the second quarter, the leading gainer to date is Texasgulf with earnings up 83% from a year ago. The worst drop was at Reichhold Chemicals, whose earnings are down 97%. Of the 25 companies, 19 suffered lower earnings than in second-quarter 1979.

Companies with earnings down more than half from a year ago in the second quarter also included B. F. Goodrich, off 59%; Monsanto, off 61%; and Akzona, off 71%. Other notable drops at the largest companies were 16% at Union Carbide, 20% at Dow Chemical, 25% at American Cyanamid, 34% at Du Pont, and 44% at Celanese.

Sales fell at four of the companies in the second quarter—1% at Celanese and National Distillers, 4% at PPG Industries, and 6% at Reichhold Chemicals. No company's sales were lower for the first half of the year.

At the other extreme, there were only four companies with double-digit earnings increases in the second quarter. Besides Texasgulf's 83% jump on an 18% sales increase, W. R. Grace's earnings rose 47% on a 13% sales gain, Big Three Industries'

## Only a few companies manage earnings gain in second quarter

| \$ Millions                      | Second-quarter 1980 |                  |                       |                  |                                 |      | First-half 1980 |                  |                       |                  |                                 |      |
|----------------------------------|---------------------|------------------|-----------------------|------------------|---------------------------------|------|-----------------|------------------|-----------------------|------------------|---------------------------------|------|
|                                  | Sales               | Change from 1979 | Earnings <sup>a</sup> | Change from 1979 | Profit margin <sup>b</sup> 1980 | 1979 | Sales           | Change from 1979 | Earnings <sup>a</sup> | Change from 1979 | Profit margin <sup>b</sup> 1980 | 1979 |
| Akzona                           | \$ 244.4            | 3%               | \$ 1.4                | -71%             | 0.6%                            | 2.1% | \$ 537.6        | 8%               | \$ 6.8                | -53%             | 1.3%                            | 2.9% |
| Air Products                     | 356.9               | 16               | 26.9                  | 8                | 7.6                             | 8.1  | 734.1           | 21               | 61.2                  | 24               | 8.3                             | 8.1  |
| American Cyanamid                | 837.0               | 5                | 32.6                  | -25              | 3.9                             | 5.4  | 1667.0          | 8                | 70.6                  | -16              | 4.2                             | 5.4  |
| Big Three Industries             | 154.3               | 26               | 20.4                  | 36               | 13.2                            | 12.3 | 307.1           | 26               | 40.7                  | 37               | 13.3                            | 12.3 |
| Celanese                         | 803.0               | -1               | 25.0                  | -44              | 3.1                             | 5.6  | 1650.0          | 6                | 61.0                  | -21              | 3.7                             | 5.0  |
| Diamond Shamrock                 | 769.1               | 34               | 56.3                  | 6                | 7.3                             | 9.2  | 1524.5          | 41               | 112.6                 | 36               | 7.4                             | 7.6  |
| Dow Chemical                     | 2522.7              | 9                | 171.2                 | -20              | 6.8                             | 9.3  | 5332.2          | 22               | 401.7                 | 3                | 7.5                             | 8.9  |
| Du Pont <sup>c</sup>             | 3412.3              | 5                | 176.6                 | -34              | 5.1                             | 8.3  | 6980.2          | 11               | 421.0                 | -18              | 6.0                             | 8.2  |
| Ethyl <sup>c</sup>               | 440.5               | 7                | 24.1                  | -8               | 5.5                             | 6.4  | 879.1           | 12               | 45.3                  | -4               | 5.2                             | 6.1  |
| Ferro                            | 170.9               | 17               | 4.7                   | -35              | 2.8                             | 5.0  | 340.4           | 21               | 11.8                  | -27              | 3.5                             | 5.0  |
| Freeport Minerals <sup>c</sup>   | 147.6               | 20               | 29.8                  | 18               | 20.2                            | 20.7 | 304.0           | 33               | 65.1                  | 43               | 21.4                            | 20.0 |
| B. F. Goodrich                   | 749.9               | 0                | 10.0                  | -59              | 1.3                             | 3.3  | 1520.0          | 1                | 30.0                  | -40              | 2.0                             | 3.4  |
| W. R. Grace                      | 1541.4              | 13               | 86.7                  | 47               | 5.6                             | 4.4  | 2905.5          | 15               | 151.9                 | 53               | 5.2                             | 3.9  |
| Hercules                         | 624.0               | 6                | 26.9                  | -33              | 4.3                             | 6.8  | 1269.0          | 11               | 60.6                  | -21              | 4.8                             | 6.7  |
| Monsanto                         | 1548.6              | 1                | 23.2                  | -61              | 1.5                             | 3.9  | 3371.1          | 7                | 187.4                 | -15              | 5.6                             | 7.0  |
| National Distillers <sup>c</sup> | 512.7               | -1               | 29.6                  | -3               | 5.8                             | 5.9  | 1071.2          | 1                | 72.7                  | 16               | 6.8                             | 5.9  |
| Olin                             | 483.4               | 2                | 27.2                  | -1               | 5.6                             | 5.8  | 958.7           | 5                | 49.2                  | 10               | 5.1                             | 4.9  |
| Pennwalt <sup>c</sup>            | 292.4               | 8                | 10.9                  | -22              | 3.7                             | 5.2  | 595.2           | 12               | 23.2                  | -3               | 3.9                             | 4.5  |
| PPG Industries                   | 753.7               | -4               | 39.7                  | -31              | 5.3                             | 7.4  | 1550.0          | 3                | 94.4                  | -12              | 6.1                             | 7.1  |
| Reichhold Chemicals              | 213.2               | -6               | 0.2                   | -97              | 0.1                             | 2.6  | 449.5           | 4                | 4.4                   | -48              | 1.0                             | 2.0  |
| Rohm & Haas                      | 467.1               | 10               | 27.0                  | -1               | 5.8                             | 6.4  | 902.8           | 11               | 54.2                  | -2               | 6.0                             | 6.8  |
| Stauffer Chemical                | 357.1               | 3                | 20.0                  | -20              | 5.6                             | 7.2  | 940.0           | 11               | 89.7                  | 3                | 9.5                             | 10.3 |
| Texasgulf <sup>c</sup>           | 240.6               | 18               | 59.1                  | 83               | 24.6                            | 15.9 | 520.6           | 38               | 136.7                 | 137              | 26.3                            | 15.3 |
| Thiokol                          | 153.2               | 5                | 7.7                   | -7               | 5.0                             | 5.7  | 308.1           | 10               | 17.3                  | 11               | 5.6                             | 5.5  |
| Union Carbide <sup>c</sup>       | 2370.9              | 4                | 149.9                 | -16              | 6.3                             | 7.8  | 4936.5          | 11               | 369.8                 | 11               | 7.5                             | 7.5  |

a After-tax, before major extraordinary or nonrecurring items, for continuing operations. b After-tax income as a percentage of sales. c Earnings exclude major extraordinary or nonrecurring items.

earnings rose 36% on a 26% sales increase, and Freeport Minerals' earnings gained 18% on a 20% sales rise. Big Three continued its aggressive growth in industrial gases and oil field services, and the other three profited from agricultural chemicals, especially in export markets, and from natural resources.

Chemical company leaders are emerging a bit startled from the second quarter. "We and other chemical producers were somewhat surprised by the severity of reduced demand in the second quarter, which also led to poor operating rates," says John D. Ong, chairman of B. F. Goodrich.

John W. Hanley, Monsanto chairman, comments, "While we had anticipated an economic downturn, we had not projected adequately the extent of the credit constraints imposed by the Federal Reserve and the significant impact that those credit constraints had on the demand for automobiles and housing."

At Dow Chemical, financial vice president G. J. Williams elaborates, "New orders dropped abruptly in the U.S. in late April, and this resulted in reduced shipments for the quarter. In most other areas of the world, business was mixed, with Latin America and some countries in Europe showing continued strength."

Business outside the U.S. helped shore up other multinationals as well. For example, Du Pont's sales abroad were up 16% in the second quarter from a year ago but flat in the U.S. with a physical volume decline in the U.S. of 14%. Similarly, Union Carbide's international sales gained 13% in the second quarter but U.S. sales were dead-even on a physical volume drop of 17%.

Some companies survived the second quarter with only moderate earnings damage because of hot-performing specialty businesses. Examples are Olin with its swimming pool chemicals market and Rohm & Haas with herbicides. Grace also comments on favorable performance from its array of chemical specialties.

From this point, some companies are prepared for worse than they expected. Dow's Williams says, "It now appears that the recession will be deeper and longer than we had previously thought. We therefore don't expect that our net income for the year will equal that of 1979."

The same sort of talk comes from James G. Affleck, chairman of American Cyanamid. "We now expect that earnings for the year as a whole will fall below the record level of 1979. Our expectations are based on the likelihood that the U.S. recession will be deeper and longer than originally anticipated." □

# Plastics demand drops sharply

**Sales of this major product group plummeted this spring, trailing far behind production and pointing toward inventory pileup**

Plastics have carried much of the load in the U.S. chemical industry's growth in the past few years. It's the only major product group in the industry that kept up its torrid growth in the 1970's from the 1960's, and it's the best bet for future growth.

But 1980 has dealt plastics a rough start in the new decade. Contrary to expectations six months ago that plastics would survive the recession with only modest damage, results this spring show a severe drop in demand, worse than the general volume drop in the broad chemical industry.

Whereas in May, the latest month for which data are available, production fell 2% from a year ago for chemicals and allied products and 12% for overall polymers (C&EN, July 21, page 11), output dropped 20% in the leading plastics, according to data from the Society of the Plastics Industry's Committee on Resin Statistics as compiled by Ernst & Whinney. As a downstream product group more immediately vulnerable to final consumer demand than basic chemicals, plastics easily might fall earlier and faster than upstream chemicals. But the May data show a very large gap indeed and foretell a lot of trouble for basic chemicals in the next few months.

The jolt in plastics demand this spring has pulled both production and sales below levels of first-half 1979. Continuation through some or all of the second half of the year could produce an infrequent event, annual decline in plastics volume. This has happened only once before in recent decades, in the equally precipitous recession of 1975.

The air pocket in plastics use probably has caught producers in a big inventory backup. SPI's data show plastics sales far behind production this spring after a general lag over much of the past year. For ex-

ample, year-to-year production dropped 20% and sales declined 29% in May after 6% and 15% drops in April for leading plastics. Before then, annual gains in sales trailed gains in production every month back to July 1979.

The inventory load will tend to hold down production over the next few months. This means low rates of plant use and a steep decline in profits.

Second-quarter reports from leading chemical companies tell the result even before the arrival of June production figures. At Monsanto, which is a big producer of styrenic plastics, operating income data (pre-tax, precorporate overhead) for plastics in the second quarter show a loss of \$13.3 million after a profit of \$9.7 million a year ago.

Other companies are more qualitative in their plastics reporting but leave no doubt that the second quarter was difficult. At Dow Chemical, the largest U.S. plastics producer, financial vice president G. J. Williams says that worldwide plastics weakened in the period. However, he adds they are still in healthy shape.

At companies less committed to the

relatively strong polyethylenes, words were more somber. This is especially true for polyvinyl chloride producers, who have the worst problems among companies in the dominant thermoplastics. PVC production slumped 28% and sales 36% in May from a year ago.

The weakness in PVC resins, used in the automotive and construction industries, was especially marked among Stauffer Chemical's U.S. product lines, according to chairman H. Barclay Morley. At Diamond Shamrock, another major PVC producer, chairman W. H. Bricker says, "Plastics showed a sharp drop in performance late in the quarter, moving from its excellent first quarter levels, primarily as a result of the depressed construction and automotive industries, its principal markets." However, Bricker adds, "Since customer inventories appear to have remained low, when it comes, a turnaround in demand should increase earnings rapidly in plastics."

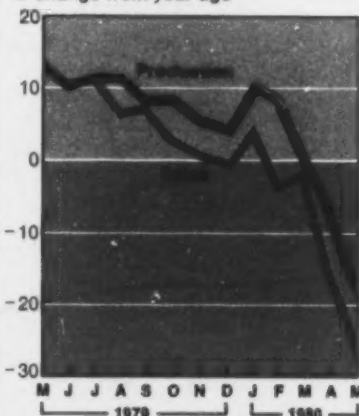
The specific source of PVC's trouble isn't hard to locate. Its leading market, construction pipe, is doing even worse than overall demand. "Demand for pipe was poor," says John McKinney, chairman of one leading PVC pipe producer, Johns-Manville. In May, SPI figures show pipe sales down 49% from May 1979. For the first five months of 1980, pipe sales fell 17% from the same period in 1979.

Unfortunately, this situation is true for several other leading plastics: The big markets are doing worse than the average and the more specialized markets aren't big enough to counter the drop. For the most widely used plastic, low-density polyethylene, cumulative 1980 sales have dropped 3% through May from a year ago, but sales in film, by far the largest single LDPE market, have dropped 8%. In May alone, total LDPE sales were down 29% and film sales down 34% from May 1979.

For polypropylene, the two largest uses, molding and fibers, both turned in substantially worse results than the product's overall 21% sales drop in May. The same is true for polystyrene's largest use in packaging, epoxy's in coatings, and polyester's in reinforced plastics.

**Plastics sales decline has led that of production**

% change from year ago



Note: Totals for epoxy, polyester, urea, melamine, phenolic, low-density polyethylene, high-density polyethylene, polypropylene, polystyrene, and polyvinyl chloride. Source: Society of the Plastics Industry's Committee on Resin Statistics as compiled by Ernst & Whinney

## May drop hit all major plastics; exports held up

|                              | Year-to-year<br>change, May |          |
|------------------------------|-----------------------------|----------|
|                              | Sales                       | Exports  |
| Epoxy                        | -26%                        | -11%     |
| Polyester                    | -43                         | -1       |
| Urea-melamine                | -24                         | 42       |
| Phenolics                    | -27                         | -24      |
| Low-density<br>polyethylene  | -29                         | 12       |
| High-density<br>polyethylene | -24                         | -8       |
| Polypropylene                | -21                         | 1        |
| Polystyrene                  | -31                         | 10       |
| Polyvinyl chloride           | -36                         | 51       |
| <b>TOTAL</b>                 | <b>-29</b>                  | <b>7</b> |

Source: Society of the Plastics Industry's Committee on Resin Statistics as compiled by Ernst & Whinney

Plastics producers had been counting on exports to balance any softening in U.S. markets in 1980. Although export totals for the first five months of the year for leading plastics do show a good gain of 17% from the same period in 1979, the year-to-year rate of gain is declining.

The export picture is actually quite mixed for different plastics. It's still very strong in volume gains for PVC, with year-to-year jumps of 78% for the first five months of 1980 and 51% in May. Exports are still increasing healthily for LDPE, the export leader, with corresponding increases of 30% and 12%, and for polystyrene, with increases of 34% and 10%.

However, among these thermoplastics, which make up the great majority of plastics exports, high-density polyethylene exports are down 3% for the first five months of 1980 and 8% in May from year-ago figures. And polypropylene exports are down 7% for the first five months, although up 1% in May.

In the thermosets, exports are small compared to the thermoplastics and are in worse shape. The only major thermoset with cumulative rising exports through May this year is epoxy, which has a 28% gain year-to-year. However, May exports of epoxies were down 11% from May 1979. For three other leading thermosets, exports are well down for the first five months of 1980 from the same period in 1979—off 19% in polyester, 27% in urea-melamine, and 15% in phenolics.

Unhappily, export volume cannot make up for the destructive drops in the U.S. plastics market. As business slowdowns loom larger in Europe and elsewhere, even this much export relief may fade. Plastics are in for a rocky time in the U.S. until demand turns around in major markets.

*William Fallwell, New York*

# Facts & Figures for Chemical R&D

Research and development is a key factor in the overall U.S. economy. It is an endeavor that, in itself, probably will absorb more than \$60 billion this year for the first time ever. Since the mid-1970's, R&D outlays have been advancing steadily at an annual rate of 11%. Furthermore, they support the efforts of some 660,000 scientists and engineers (in addition to an uncounted number of technicians and other support personnel), a number that has been expanding about 5% a year recently.

But the real economic signifi-

cance of R&D is far greater than its 2.3% share of the nation's gross national product might suggest. For R&D underpins the nation's technological progress and its health, defense, commerce, and general well-being.

Nor can its significance be measured adequately merely in terms of money and manpower. Its payoff is in new ideas, products, and processes whose contribution can be quantified only nebulously.

Nonetheless, money and manpower data are the best measures available. On the following

pages, C&EN, in its second annual report on R&D, has compiled a variety of key data: on who supplies the funds needed to make the process go, on where and how they are spent, and on the scientists and engineers who do the work. The focus throughout is on R&D in chemistry and the chemical industry. As a whole, the figures serve not just to map the present dimensions of the nation's R&D enterprise but as indicators of the trends that are likely to shape its further development in the decade ahead.

## **1** SECTION ONE Overview

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# Chemical R&D

## R&D spending rose 9% a year in past decade, but inflation wiped out most of gain

The nation continues to invest more and more money in chemical research and development. Definite figures on the total amount spent on chemical R&D are not available, however. C&EN estimates that government agencies, industry, and academic and other nonprofit organizations devote more than \$5 billion to such R&D.

At the same time, the number of employed chemists in the U.S. is growing. According to the latest National Science Foundation (NSF) data, the number rose 8% from 133,500 in 1974 to 143,700 in 1978.

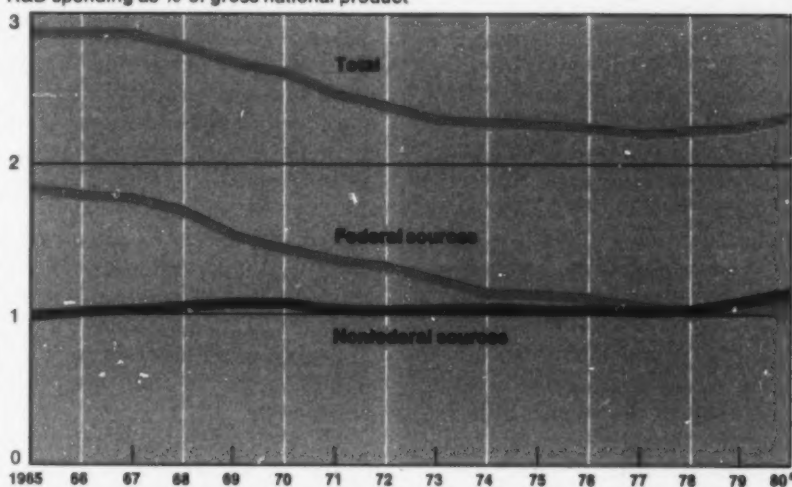
U.S. spending for all R&D is also on the increase. According to NSF estimates, it will climb 11% from \$54.3 billion in 1979 to \$60.4 billion in 1980. Between 1970 and 1980, total R&D spending has risen 133%—or nearly 9% a year.

But inflation has made these increases much less impressive in terms of constant dollars. Because of the rising costs of personnel, equipment, supplies, and overhead, the growth of total R&D spending in constant 1972 dollars will be only 2% this year and the increase between 1970 and 1980 will be just 17%—less than 2% annually.

Of deep concern to many people, the share of gross national product devoted to R&D for several years now has been well below what it was in the mid-1960's. R&D spending peaked in 1964 at just under 3% of GNP, dropped persistently between 1967 and 1974 to about 2.3% of GNP, and has hovered close to that level since. The drop during the late 1960's and early 1970's stemmed largely from decreased federal funding of R&D for defense and space projects. Since 1977, however, there has been a slight upward trend in the percentage, and this year total R&D outlays are expected to edge above 2.3% of GNP after having been just under that level during the four previous years. The 1980 increase will be partly accounted

Little change in R&D's share of U.S. GNP since early 1970's

R&D spending as % of gross national product



• Estimates. Source: National Science Foundation

for by greater federal funding of energy R&D, but also will reflect the relatively poor growth in GNP likely in this recession-wracked year. It also reflects growing outlays from non-federal sources, especially industry; funding for R&D from outside the government, which had held at about 1.1% of GNP during the late 1960's until about 1977, may hit a new high of 1.2% of GNP this year.

As far as basic science is concerned, such research as a per cent of GNP has declined from slightly less than 0.4% in 1965 to about 0.3% in 1979. The figure has remained at 0.3% or slightly less since 1973.

Actually, basic research appears to be strengthening, however, at least relative to other forms of R&D. NSF estimates that basic outlays will increase nearly 13% this year, compared to gains of 11% for both applied research and development work. After adjustment for inflation, funding for

basic research has been growing better than 5% a year since 1976; support for applied research, meanwhile, has expanded only about 2% and development only about 3% a year. One result is that basic research, which accounted for 35% of all research spending four years ago, now has a 38% share. And NSF estimates that it will get nearly 40% next year, thanks largely to increased support from the government, which funds 70% of basic work.

For many years, the leading source of the nation's R&D funds was the federal government. In 1970, the government supplied 57% of these funds, compared to 40% from industry. Universities, colleges, and other nonprofit institutions provided the remaining 3%. In recent years, the government's lead has been dwindling. In 1980, the government furnished an estimated 49% of R&D funds, and industry accounted for

48%. NSF predicts that, next year, the government's contribution actually will be slightly less than that of industry.

Over the years, noticeable changes have taken place in the emphasis put on various types of R&D. In 1960, 52% of all R&D funds went for federally supported, defense-related R&D, 3% for space-related work, and 9% for civilian-related work. By 1965, only 33% of all R&D funds went for federally supported defense R&D, 21% for space programs, and 11% for civilian programs—as a result of decreased emphasis on defense and the greatly increased stress on space efforts. In 1980, the figures are once

again considerably different. Some 24% of all R&D funds are expected to be devoted to defense projects, 8% to space, and 17% to civilian-related R&D (a large share of it concerned with health, energy, and environmental matters).

Federal spending for chemical research has about doubled from \$236 million in 1970 to an estimated \$479 million in 1980. Taking inflation into account, however, the increase was slight. In constant 1972 dollars, the spending during this period rose only 2% from \$260 million to an estimated \$265 million.

Among federal agencies, the leading supporters of total R&D are (in decreasing order) the Department of Defense, the Department of Energy, and the National Aeronautics & Space Administration. In the area of basic chemical research, the main sources of federal funds are the National Science Foundation, the De-

partment of Energy, the National Institutes of Health, and the Department of Defense. In 1980, the government has made a special effort to boost support of basic research. But because of inflation, the real growth of such spending was minor. According to C&EN estimates, R&D carried out by the chemicals and allied products industry rose 14% in 1979 to \$4.1 billion. Of the amount in 1979, 90% was supplied by the industry itself and only 10% by the government. This situation differs markedly from that in universities, where the chief provider of R&D funds is Uncle Sam.

In 1979, the industrial chemicals industry, according to C&EN estimates, performed R&D costing \$2.1 billion. This, too, was a gain of 14% over 1978. Producers of industrial chemicals have more than doubled their R&D spending significantly during the past decade. In constant 1972 dollars, however, the gain during this period has been a mere 8%, from \$1.2 billion in 1969 to \$1.3 billion last year.

Even though spending on R&D in the industrial chemicals industry has been growing over the years, it has declined as a percentage of the industry's sales from 4.7% in 1965 to an estimated 3.3% in 1979. In the drug industry, not only is R&D spending as a per cent of net sales stabler but also decidedly higher. The figures were 6.4% in 1965 and an estimated 6.3% in 1979. It had reached a peak of 6.7% in 1970.

U.S. companies are doing more and more R&D these days in their foreign affiliates. One reason is that such R&D makes it easier for U.S. companies to sell their products abroad by tailoring them to local needs. Between 1978 and 1979, the U.S. chemicals and allied products industry increased its R&D in its foreign affiliates 16% from an estimated \$396 million to \$460 million. The growth was even greater in the drug industry, which boosted R&D in its foreign affiliates 19% from an estimated \$243 million in 1978 to \$290 million in 1979.

The federal government pays for two thirds of the R&D done in universities and colleges. Most of the remaining financial support comes from the institutions themselves (13% of the total) or from state and local governments (9%). Industry's share is less than 5%.

Of the \$5.3 billion spent by universities on R&D in 1979, 70% went for basic research, 25% for applied research, and 5% for development.

Actually, universities conducted a higher percentage of basic research in

1969. In that year, such research accounted for 77% of their total R&D spending of \$2.2 billion. The remainder consisted of 18% for applied research and 5% for development.

Only 4% of university R&D is devoted to chemistry. This is not much different from the 5% for 1968.

Data from NSF and other sources provide information on characteristics of R&D manpower. NSF data show that, of the 146,600 chemists in the 1978 labor force, which includes both employed and unemployed, 91% were men and 9% women. Some 95% were white, 2% black, 2% Asian, and 1% other minorities.

In 1978, 65% of employed chemists worked in industry and 21% in educational institutions. Some 14% worked in basic research, 16% in applied research, 15% in development, 10% in teaching, and the remaining 45% in other activities, such as production, management, and consulting.

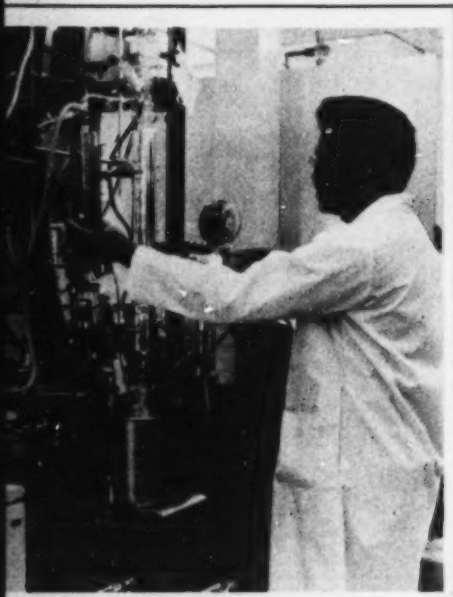
The number of chemists working for the federal government has fluctuated moderately in recent years. It rose from 8100 in 1970 to 8400 in 1972, dropped to 8000 in 1975, then climbed back to 8300 in 1978. The federal agencies that employ the most chemists are (in decreasing order) the Department of Health & Human Services, the Department of Defense, and the Department of Agriculture.

In the chemicals and allied products industry, the number of R&D scientists and engineers has risen 27% from 38,900 in 1968 to 49,400 in 1979. On the other hand, the number of such personnel in the industrial chemicals industry has declined slightly from 22,300 to 21,800.

The number of R&D scientists and engineers per 1000 employees in the chemicals and allied products industry has climbed 20% from 35 in 1968 to 42 in 1978. In the same period, the number of such personnel per 1000 employees in the industrial chemicals industry rose 22% from 32 to 39.

With the anticipated dropoff in enrollments in the 1980's in the universities, the number of scientists and engineers employed in these schools is expected to decline. In the 1970's, however, the number increased. For full- and part-time chemists, the number employed at Ph.D.-granting institutions rose 15% from 7900 in 1973 to 9100 in 1979. For full-time chemists employed at these institutions, the number climbed 13% from 6900 in 1973 to 7800 in 1979.

Despite concern about the nation's current economic downturn, the U.S. investment in chemical R&D is certain to increase in the years immediately ahead—both in total dollars spent and manpower employed. □



## R&D outlays likely to rise 11% this year and next

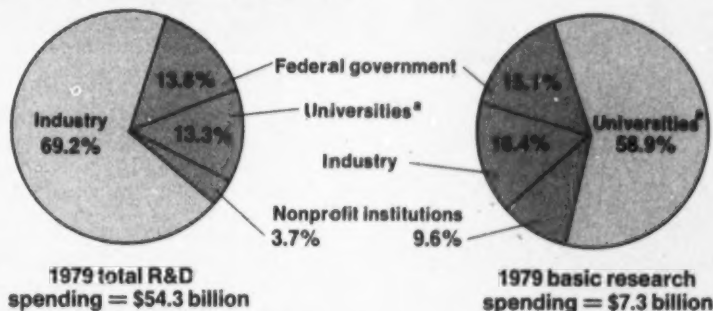
*Spending is even expanding after adjustment for inflation thanks largely to industrial funds, but not so much as during the late 1970's*

Trends in national spending for R&D can be cheering or a cause for concern, depending on your perspective. The total U.S. R&D effort has been expanding—measured in current dollars—at an 11- to 12%-a-year clip for the past few years. And the National Science Foundation is looking for another 11% rise in 1981, to a total it estimates at \$66.7 billion. That's double what was spent six years ago.

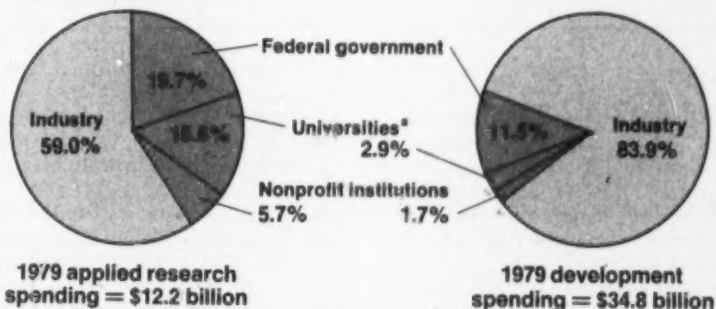
That means, too, that even during a period of rampant inflation, R&D is making at least a little headway, in real terms. But not much. After adjusting for inflation, R&D spending is likely to grow at an annual rate of only 1% this year and next. That's a stronger performance than occurred during the late 1960's and early 1970's, when real spending was drifting lower about 1% a year. But it doesn't stack up very favorably against the 1975-79 period, when a real growth of better than 4% a year was under way.

Whatever growth has been taking place, moreover, can be credited to the private sector of the economy. Federal spending, in constant-dollar terms, will show little change this year and may be down slightly next year. Meanwhile, nonfederal funding of R&D, more than 90% of which is from industry, is expected to be up 2 to 3% a year.

### Most R&D is carried out by industry but basic research is done largely in universities



### Applied research and development is focused in industrial labs



\* Includes associated federally funded research and development centers.  
Source: National Science Foundation

## TRENDS IN R&D: Nonfederal outlays represent a growing share of the total

| % of total outlays | 1980 <sup>a</sup> | 1979 <sup>a</sup> | 1978 | 1977 | 1976 | 1975 | 1974 | 1973 | 1972 | 1971 | 1970 | 1969 | 1968 | 1967 | 1966 | 1965 | 1964 | 1963 | 1962 | 1961 |
|--------------------|-------------------|-------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| <b>Federal</b>     | 49%               | 49%               | 50%  | 51%  | 51%  | 51%  | 51%  | 53%  | 55%  | 56%  | 57%  | 58%  | 61%  | 62%  | 64%  | 65%  | 66%  | 66%  | 64%  | 65%  |
| Defense related    | 24                | 24                | 24   | 25   | 26   | 27   | 28   | 31   | 32   | 32   | 33   | 34   | 35   | 35   | 33   | 33   | 37   | 41   | 48   | 50   |
| Space related      | 8                 | 7                 | 7    | 8    | 8    | 7    | 7    | 7    | 8    | 9    | 10   | 11   | 13   | 14   | 19   | 21   | 19   | 14   | 7    | 6    |
| Civilian related   | 17                | 18                | 19   | 18   | 17   | 17   | 16   | 15   | 15   | 14   | 13   | 13   | 13   | 13   | 12   | 11   | 11   | 10   | 10   | 9    |
| <b>Nonfederal</b>  | 51                | 51                | 50   | 49   | 49   | 49   | 49   | 47   | 45   | 44   | 43   | 42   | 39   | 38   | 36   | 35   | 34   | 34   | 36   | 35   |

Note: Data may not total 100% because of rounding. <sup>a</sup> Estimated. Source: National Science Foundation

## SOURCES OF R&D FUNDS: Industry is overtaking government as biggest supplier . . .

| \$ Billions, current          | 1981 <sup>a</sup> | 1980 <sup>a</sup> | 1979 <sup>a</sup> | 1978          | 1977          | 1976          | 1975          | 1974          | 1973          | 1972          | 1971          | 1970          | Annual change |           |
|-------------------------------|-------------------|-------------------|-------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|-----------|
|                               |                   |                   |                   |               |               |               |               |               |               |               |               |               | 1979-80       | 1970-80   |
| Federal government            | \$32.0            | \$29.4            | \$26.8            | \$24.1        | \$21.8        | \$19.8        | \$18.2        | \$16.8        | \$16.3        | \$15.8        | \$14.9        | \$14.7        | 10%           | 7%        |
| Industry                      | 32.2              | 28.7              | 25.5              | 22.4          | 19.7          | 17.9          | 15.8          | 14.9          | 13.3          | 11.7          | 10.8          | 10.4          | 13            | 11        |
| Universities and colleges     | 1.5               | 1.3               | 1.2               | 1.0           | 0.9           | 0.8           | 0.8           | 0.7           | 0.6           | 0.6           | 0.5           | 0.5           | 8             | 10        |
| Other non-profit institutions | 1.0               | 1.0               | 0.9               | 0.8           | 0.7           | 0.6           | 0.5           | 0.5           | 0.4           | 0.4           | 0.4           | 0.3           | 11            | 13        |
| <b>TOTAL</b>                  | <b>\$66.7</b>     | <b>\$60.4</b>     | <b>\$54.3</b>     | <b>\$48.3</b> | <b>\$43.0</b> | <b>\$39.0</b> | <b>\$35.3</b> | <b>\$32.8</b> | <b>\$30.6</b> | <b>\$28.4</b> | <b>\$26.6</b> | <b>\$25.9</b> | <b>11%</b>    | <b>9%</b> |

<sup>a</sup> Estimated. Source: National Science Foundation

## . . . as only its contribution shows growth in constant dollars, this year

| \$ Billions, constant (1972)  | 1981 <sup>a</sup> | 1980 <sup>a</sup> | 1979 <sup>a</sup> | 1978          | 1977          | 1976          | 1975          | 1974          | 1973          | 1972          | 1971          | 1970          | Annual change |           |
|-------------------------------|-------------------|-------------------|-------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|-----------|
|                               |                   |                   |                   |               |               |               |               |               |               |               |               |               | 1979-80       | 1970-80   |
| Federal government            | \$16.0            | \$16.2            | \$16.2            | \$15.8        | \$15.3        | \$14.9        | \$14.4        | \$14.6        | \$15.5        | \$15.8        | \$15.5        | \$16.1        | 0%            | 0%        |
| Industry                      | 16.1              | 15.8              | 15.4              | 14.8          | 13.9          | 13.2          | 12.4          | 12.8          | 12.6          | 11.7          | 11.3          | 11.4          | 3             | 3         |
| Universities and colleges     | 0.8               | 0.7               | 0.7               | 0.7           | 0.6           | 0.6           | 0.6           | 0.6           | 0.6           | 0.6           | 0.6           | 0.5           | 0             | 3         |
| Other non-profit institutions | 0.5               | 0.5               | 0.5               | 0.5           | 0.5           | 0.4           | 0.4           | 0.4           | 0.4           | 0.4           | 0.4           | 0.4           | 0             | 2         |
| <b>TOTAL</b>                  | <b>\$33.4</b>     | <b>\$33.3</b>     | <b>\$32.8</b>     | <b>\$31.8</b> | <b>\$30.3</b> | <b>\$29.2</b> | <b>\$27.9</b> | <b>\$28.5</b> | <b>\$29.1</b> | <b>\$28.4</b> | <b>\$27.7</b> | <b>\$28.4</b> | <b>2%</b>     | <b>2%</b> |

<sup>a</sup> Estimated. Source: National Science Foundation

## PERFORMERS OF R&D: More than two thirds is done by industry . . .

| \$ Billions, current            | 1981 <sup>a</sup> | 1980 <sup>a</sup> | 1979 <sup>a</sup> | 1978          | 1977          | 1976          | 1975          | 1974          | 1973          | 1972          | 1971          | 1970          | Annual change |           |
|---------------------------------|-------------------|-------------------|-------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|-----------|
|                                 |                   |                   |                   |               |               |               |               |               |               |               |               |               | 1979-80       | 1970-80   |
| Industry                        | \$47.0            | \$42.4            | \$37.6            | \$33.4        | \$29.9        | \$27.0        | \$24.2        | \$22.9        | \$21.2        | \$19.6        | \$18.3        | \$18.1        | 13%           | 9%        |
| Federal government              | 8.5               | 7.8               | 7.5               | 6.9           | 6.1           | 5.7           | 5.4           | 4.8           | 4.6           | 4.5           | 4.2           | 3.9           | 4             | 7         |
| Universities and colleges       | 6.7               | 6.1               | 5.3               | 4.6           | 4.1           | 3.7           | 3.4           | 3.0           | 2.9           | 2.7           | 2.5           | 2.3           | 15            | 10        |
| Associated FFRDC's <sup>b</sup> | 2.2               | 2.0               | 1.8               | 1.7           | 1.4           | 1.1           | 1.0           | 0.9           | 0.8           | 0.8           | 0.7           | 0.7           | 11            | 11        |
| Other nonprofit institutions    | 2.4               | 2.2               | 2.0               | 1.7           | 1.5           | 1.4           | 1.3           | 1.2           | 1.0           | 1.0           | 0.9           | 0.9           | 10            | 9         |
| <b>TOTAL</b>                    | <b>\$66.7</b>     | <b>\$60.4</b>     | <b>\$54.3</b>     | <b>\$48.3</b> | <b>\$43.0</b> | <b>\$39.0</b> | <b>\$35.3</b> | <b>\$32.8</b> | <b>\$30.6</b> | <b>\$28.4</b> | <b>\$26.6</b> | <b>\$25.9</b> | <b>11%</b>    | <b>9%</b> |

<sup>a</sup> Estimated. <sup>b</sup> Federally funded research and development centers administered by universities and colleges. Source: National Science Foundation

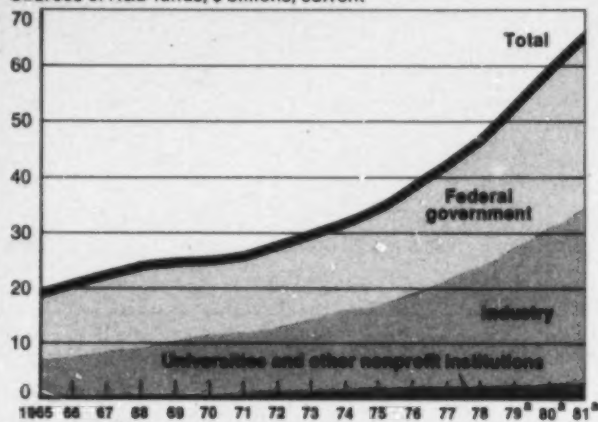
## . . . but increases in R&D spending are slight after accounting for inflation

| \$ Billions, constant (1972)    | 1981 <sup>a</sup> | 1980 <sup>a</sup> | 1979 <sup>a</sup> | 1978          | 1977          | 1976          | 1975          | 1974          | 1973          | 1972          | 1971          | 1970          | Annual change |           |
|---------------------------------|-------------------|-------------------|-------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|-----------|
|                                 |                   |                   |                   |               |               |               |               |               |               |               |               |               | 1979-80       | 1970-80   |
| Industry                        | \$23.5            | \$23.3            | \$22.7            | \$22.0        | \$21.1        | \$20.2        | \$19.0        | \$19.7        | \$20.1        | \$19.6        | \$19.1        | \$19.8        | 3%            | 2%        |
| Federal government              | 4.3               | 4.3               | 4.5               | 4.5           | 4.3           | 4.3           | 4.3           | 4.3           | 4.4           | 4.5           | 4.3           | 4.2           | -4            | 0         |
| Universities and colleges       | 3.4               | 3.3               | 3.2               | 3.0           | 2.9           | 2.8           | 2.7           | 2.7           | 2.8           | 2.7           | 2.6           | 2.6           | 3             | 2         |
| Associated FFRDC's <sup>b</sup> | 1.1               | 1.1               | 1.1               | 1.1           | 1.0           | 0.9           | 0.8           | 0.8           | 0.8           | 0.8           | 0.7           | 0.8           | 0             | 3         |
| Other nonprofit institutions    | 1.2               | 1.2               | 1.2               | 1.1           | 1.1           | 1.0           | 1.0           | 1.0           | 1.0           | 1.0           | 1.0           | 1.0           | 0             | 2         |
| <b>TOTAL</b>                    | <b>\$33.4</b>     | <b>\$33.3</b>     | <b>\$32.8</b>     | <b>\$31.8</b> | <b>\$30.3</b> | <b>\$29.2</b> | <b>\$27.9</b> | <b>\$28.5</b> | <b>\$29.1</b> | <b>\$28.4</b> | <b>\$27.7</b> | <b>\$28.4</b> | <b>2%</b>     | <b>2%</b> |

<sup>a</sup> Estimated. <sup>b</sup> Federally funded research and development centers administered by universities and colleges. Source: National Science Foundation

## Expenditures for R&D rose steadily during the 1970's...

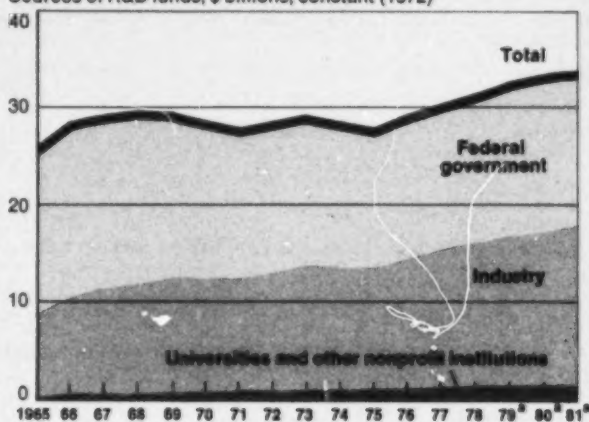
Sources of R&D funds, \$ billions, current



a Estimates. Source: National Science Foundation

## ...but inflation eliminated much of the gain, especially in government spending

Sources of R&D funds, \$ billions, constant (1972)



## CHARACTER OF R&D: Development efforts absorb the major share of R&D funds...

| \$ Billions, current | 1980 <sup>a</sup> | 1979 <sup>a</sup> | 1978   | 1977   | 1976   | 1975   | 1974   | 1973   | 1972   | 1971   | 1970   | Annual change |         |
|----------------------|-------------------|-------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------------|---------|
|                      |                   |                   |        |        |        |        |        |        |        |        |        | 1979-80       | 1970-80 |
| Basic research       | \$ 8.2            | \$ 7.3            | \$ 6.4 | \$ 5.5 | \$ 4.9 | \$ 4.6 | \$ 4.2 | \$ 3.9 | \$ 3.7 | \$ 3.6 | \$ 3.5 | 12%           | 9%      |
| Applied research     | 13.5              | 12.2              | 10.9   | 9.9    | 9.1    | 8.0    | 7.4    | 6.7    | 6.1    | 5.8    | 5.7    | 11            | 9       |
| Development          | 38.6              | 34.8              | 31.1   | 27.6   | 25.0   | 22.8   | 21.3   | 20.1   | 18.6   | 17.2   | 16.7   | 11            | 9       |

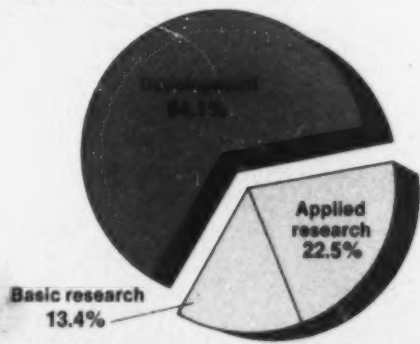
a Estimated. Source: National Science Foundation

## ... but this year basic research will show largest gain in spending

| \$ Billions, constant (1972) | 1980 <sup>a</sup> | 1979 <sup>a</sup> | 1978   | 1977   | 1976   | 1975   | 1974   | 1973   | 1972   | 1971   | 1970   | Annual change |         |
|------------------------------|-------------------|-------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------------|---------|
|                              |                   |                   |        |        |        |        |        |        |        |        |        | 1979-80       | 1970-80 |
| Basic research               | \$ 4.5            | \$ 4.4            | \$ 4.2 | \$ 3.9 | \$ 3.7 | \$ 3.6 | \$ 3.7 | \$ 3.7 | \$ 3.7 | \$ 3.7 | \$ 3.8 | 2%            | 2%      |
| Applied research             | 7.4               | 7.4               | 7.1    | 7.0    | 6.8    | 6.3    | 6.4    | 6.3    | 6.1    | 6.1    | 6.3    | 0             | 2       |
| Development                  | 21.3              | 21.0              | 20.4   | 19.5   | 18.7   | 18.0   | 18.4   | 19.0   | 18.6   | 17.9   | 18.3   | 1             | 2       |

a Estimated. Source: National Science Foundation

## Development accounts for most of R&D spending



1979 total R&D spending = \$54.3 billion

Source: National Science Foundation

## EMPLOYED SCIENTISTS AND ENGINEERS: Chemists account for 6% of total

| Thousands               | 1978   | 1976   | 1974   |
|-------------------------|--------|--------|--------|
| Physical scientists     | 212.4  | 227.4  | 201.4  |
| Chemists                | 143.7  | 150.4  | 133.5  |
| Physicists/ astronomers | 51.2   | 58.6   | 52.7   |
| Engineers               | 1268.4 | 1240.7 | 1212.6 |
| Chemical                | 62.0   | na     | na     |
| Other scientists        | 992.4  | 909.1  | 834.2  |
| TOTAL                   | 2473.2 | 2377.2 | 2248.2 |

na = not available. Source: National Science Foundation

## SCIENTISTS AND ENGINEERS BY SEX, RACE: Women comprise 11% of chemical labor force

| Thousands, 1978            | Total <sup>a</sup> |               |              | Labor force <sup>b</sup> |               |              |               |             |             |             |
|----------------------------|--------------------|---------------|--------------|--------------------------|---------------|--------------|---------------|-------------|-------------|-------------|
|                            | Total              | Male          | Female       | Total                    | Male          | Female       | White         | Black       | Asian       | Other races |
| <b>Physical scientists</b> | <b>254.6</b>       | <b>231.8</b>  | <b>22.8</b>  | <b>216.7</b>             | <b>200.7</b>  | <b>16.0</b>  | <b>206.8</b>  | <b>3.2</b>  | <b>5.3</b>  | <b>1.4</b>  |
| Chemists                   | 173.7              | 154.7         | 19.0         | 146.6                    | 133.4         | 13.2         | 139.0         | 3.1         | 3.4         | 1.1         |
| Physicists/<br>astronomers | 61.6               | 59.3          | 2.2          | 52.3                     | 50.9          | 1.4          | 50.4          | 0.1         | 1.5         | 0.2         |
| <b>Engineers</b>           | <b>1396.4</b>      | <b>1374.6</b> | <b>21.7</b>  | <b>1285.0</b>            | <b>1264.5</b> | <b>20.5</b>  | <b>1234.4</b> | <b>10.6</b> | <b>26.4</b> | <b>13.6</b> |
| Chemical                   | 67.9               | 65.0          | 2.9          | 62.8                     | 60.1          | 2.7          | 59.9          | 0.3         | 1.6         | 0.9         |
| <b>Other scientists</b>    | <b>1090.4</b>      | <b>868.9</b>  | <b>221.6</b> | <b>1005.9</b>            | <b>805.2</b>  | <b>200.7</b> | <b>952.4</b>  | <b>25.8</b> | <b>19.6</b> | <b>8.2</b>  |
| <b>TOTAL</b>               | <b>2741.4</b>      | <b>2475.3</b> | <b>266.1</b> | <b>2507.6</b>            | <b>2270.4</b> | <b>237.2</b> | <b>2393.6</b> | <b>39.6</b> | <b>51.3</b> | <b>23.2</b> |

a Includes both those in or outside the labor force. b Includes both those employed or unemployed. Source: National Science Foundation

## SCIENTISTS AND ENGINEERS BY AGE: Half of men and three fourths of women are under 40

| Thousands, 1978                           | Total         | 24 and<br>under | 25-29        | 30-34        | 35-39        | 40-44        | 45-49        | 50-54        | 55-59        | 60-64        | 65-69       | 70 and<br>over |
|-------------------------------------------|---------------|-----------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|-------------|----------------|
| <b>Chemists</b>                           | <b>173.7</b>  | <b>20.2</b>     | <b>26.6</b>  | <b>18.6</b>  | <b>21.2</b>  | <b>19.3</b>  | <b>17.7</b>  | <b>16.4</b>  | <b>14.7</b>  | <b>9.6</b>   | <b>6.5</b>  | <b>2.9</b>     |
| Men                                       | 154.7         | 15.8            | 22.1         | 15.5         | 19.0         | 18.2         | 16.5         | 15.4         | 14.0         | 9.3          | 6.0         | 2.9            |
| Women                                     | 19.0          | 4.4             | 4.5          | 3.1          | 2.2          | 1.0          | 1.2          | 1.0          | 0.7          | 0.3          | 0.5         | 0.1            |
| <b>Chemical<br/>engineers</b>             | <b>67.9</b>   | <b>5.9</b>      | <b>12.4</b>  | <b>9.8</b>   | <b>8.1</b>   | <b>6.7</b>   | <b>5.5</b>   | <b>6.5</b>   | <b>6.8</b>   | <b>4.3</b>   | <b>1.4</b>  | <b>0.7</b>     |
| Men                                       | 65.0          | 5.0             | 10.9         | 9.3          | 8.0          | 6.7          | 5.5          | 6.5          | 6.8          | 4.3          | 1.4         | 0.7            |
| Women                                     | 2.9           | 0.8             | 1.5          | 0.5          | 0.1          | a            | a            | a            | a            | a            | a           | a              |
| <b>Total scientists<br/>and engineers</b> | <b>2741.4</b> | <b>212.6</b>    | <b>436.1</b> | <b>426.3</b> | <b>365.4</b> | <b>303.1</b> | <b>283.9</b> | <b>262.8</b> | <b>200.9</b> | <b>121.7</b> | <b>75.8</b> | <b>52.9</b>    |
| Men                                       | 2475.3        | 147.6           | 367.5        | 380.0        | 338.9        | 286.6        | 270.1        | 252.8        | 192.5        | 117.8        | 71.5        | 49.8           |
| Women                                     | 266.1         | 64.8            | 68.6         | 46.3         | 26.6         | 16.5         | 13.8         | 10.0         | 8.4          | 3.9          | 4.1         | 3.2            |

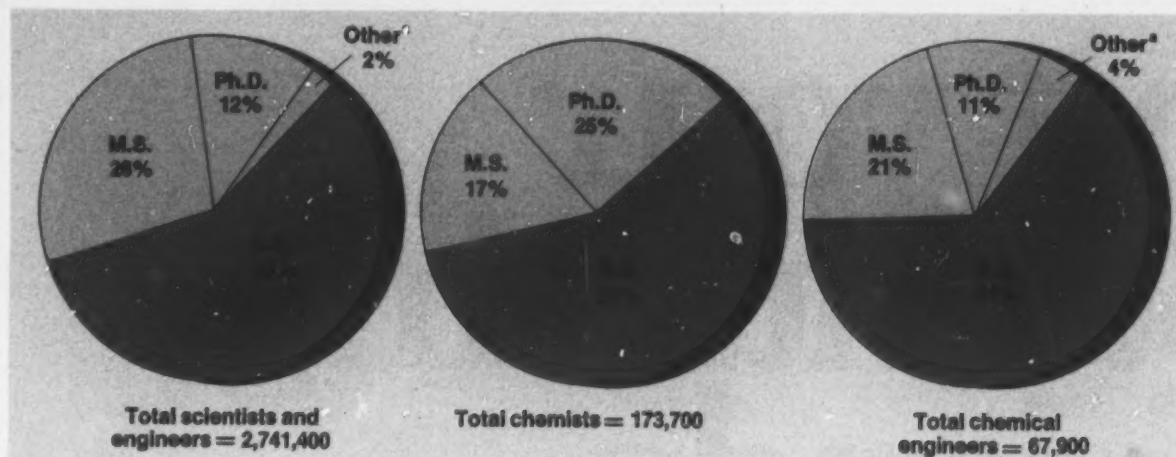
a Too few cases to estimate. Source: National Science Foundation

## EMPLOYED CHEMISTS AND CHEMICAL ENGINEERS: Most work for industry and do R&D

| % in category, 1978                               | Total<br>chemists | Men<br>chemists | Women<br>chemists | Women<br>as a %<br>of total<br>chemists | Total<br>Ch.E.'s | Men<br>Ch.E.'s | Women<br>Ch.E.'s | Women<br>as a %<br>of total<br>Ch.E.'s |
|---------------------------------------------------|-------------------|-----------------|-------------------|-----------------------------------------|------------------|----------------|------------------|----------------------------------------|
| <b>Employer</b>                                   |                   |                 |                   |                                         |                  |                |                  |                                        |
| Industry                                          | 65.0%             | 65.3%           | 60.6%             | 8.1%                                    | 90.2%            | 89.9%          | 92.0%            | 4.2%                                   |
| Educational institutions                          | 21.0              | 20.8            | 23.8              | 9.8                                     | 4.3              | 4.3            | 4.0              | 3.8                                    |
| Nonprofit organizations                           | 2.8               | 2.8             | 4.1               | 12.5                                    | 1.1              | 1.2            | a                | a                                      |
| Federal government                                | 5.7               | 5.6             | 5.7               | 8.8                                     | 2.9              | 2.9            | 4.0              | 5.6                                    |
| Military                                          | 0.3               | 0.3             | a                 | a                                       | 0.2              | 0.2            | a                | a                                      |
| State and local governments                       | 3.0               | 3.0             | 3.3               | 9.3                                     | 0.5              | 0.6            | a                | a                                      |
| Other government agencies                         | 1.8               | 1.8             | 2.5               | 11.5                                    | 0.5              | 0.6            | a                | a                                      |
| Others                                            | 0.4               | 0.4             | a                 | a                                       | 0.3              | 0.3            | a                | a                                      |
| <b>Work activity</b>                              |                   |                 |                   |                                         |                  |                |                  |                                        |
| Basic research                                    | 13.6              | 12.1            | 29.5              | 18.8                                    | 1.8              | 1.9            | 3.8              | 9.1                                    |
| Applied research                                  | 15.9              | 15.7            | 18.0              | 9.8                                     | 5.7              | 5.7            | 3.8              | 2.9                                    |
| Development                                       | 15.0              | 15.2            | 12.3              | 7.1                                     | 37.3             | 38.0           | 19.2             | 2.2                                    |
| Management or administration<br>of R&D            | 13.2              | 14.2            | 3.3               | 2.1                                     | 9.1              | 8.8            | 15.4             | 7.1                                    |
| Management or administration<br>of other than R&D | 8.4               | 8.9             | 4.1               | 4.2                                     | 10.5             | 11.0           | a                | a                                      |
| Teaching                                          | 9.9               | 10.0            | 9.0               | 7.9                                     | 3.2              | 3.4            | a                | a                                      |
| Consulting                                        | 1.6               | 1.6             | 1.6               | 8.7                                     | 3.7              | 3.7            | a                | a                                      |
| Production and inspection                         | 17.6              | 17.9            | 15.6              | 7.6                                     | 21.4             | 20.3           | 42.3             | 8.3                                    |
| Other activities                                  | 4.8               | 4.4             | 6.6               | 12.1                                    | 7.3              | 7.2            | 16.5             | 6.5                                    |

a Too few cases to estimate. Source: National Science Foundation

## Highest degree for most scientists and engineers is B.S.



a Includes professional, associate, and other degrees. Source: National Science Foundation

## EMPLOYED CHEMISTS AND CHEMICAL ENGINEERS, ACTIVITY BY EMPLOYER: Development work is the biggest function for those in industry

| % in work activity, 1978    | Basic research | Applied research | Development | Management or administration |                | Teaching | Consulting | Production and inspection | Other activities |
|-----------------------------|----------------|------------------|-------------|------------------------------|----------------|----------|------------|---------------------------|------------------|
|                             |                |                  |             | R&D                          | Other than R&D |          |            |                           |                  |
| Chemists                    |                |                  |             |                              |                |          |            |                           |                  |
| Industry                    | 4.3%           | 18.5%            | 21.8%       | 17.9%                        | 9.8%           | 0.3%     | 1.8%       | 20.7%                     | 4.9%             |
| Educational institutions    | 37.2           | 4.4              | 1.4         | 2.0                          | 3.4            | 45.1     | 0.3        | 2.4                       | 3.8              |
| Nonprofit organizations     | 40.0           | 22.5             | 5.0         | 7.5                          | 5.0            | 2.5      | 5.0        | 10.0                      | 2.5              |
| Federal government          | 30.0           | 30.0             | 8.8         | 12.5                         | 6.3            | a        | a          | 8.8                       | 3.6              |
| Military                    | 50.0           | 25.0             | a           | a                            | 25.0           | a        | a          | a                         | a                |
| State and local governments | 2.3            | 11.6             | a           | 4.7                          | 18.6           | 2.3      | 2.3        | 51.2                      | 7.0              |
| Other government agencies   | 3.8            | 23.1             | a           | 7.7                          | 15.5           | a        | 11.5       | 30.8                      | 7.6              |
| Others                      | a              | 20.0             | 40.0        | 20.0                         | a              | a        | a          | a                         | 20.0             |
| Chemical engineers          |                |                  |             |                              |                |          |            |                           |                  |
| Industry                    | 0.5            | 4.9              | 39.8        | 9.6                          | 9.5            | 0.5      | 4.0        | 23.3                      | 7.9              |
| Educational institutions    | 23.2           | 3.8              | 11.5        | a                            | a              | 61.5     | a          | a                         | a                |
| Nonprofit organizations     | a              | 28.6             | 14.3        | 28.5                         | a              | a        | 14.3       | a                         | 14.3             |
| Federal government          | 5.5            | 16.7             | 16.7        | 5.5                          | 50.0           | a        | a          | a                         | 5.6              |
| Military                    | a              | a                | a           | a                            | a              | a        | a          | 100.0                     | a                |
| State and local governments | a              | a                | a           | a                            | 33.3           | a        | a          | 66.7                      | a                |
| Other government agencies   | 33.3           | 33.3             | a           | a                            | 33.3           | a        | a          | a                         | a                |
| Others                      | a              | a                | 50.0        | a                            | 50.0           | a        | a          | a                         | a                |

a Too few cases to estimate. Source: National Science Foundation

## ORIGIN OF PAPERS IN *CHEMICAL ABSTRACTS*:<sup>a</sup> U.S. leads world in chemical publications

|              | Number of papers |                |                |                |                |                |                |                |
|--------------|------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
|              | 1979             | 1978           | 1977           | 1976           | 1975           | 1974           | 1973           | 1972           |
| U.S.         | 101,772          | 96,420         | 89,974         | 81,517         | 81,697         | 70,841         | 71,029         | 76,815         |
| U.S.S.R.     | 70,563           | 74,112         | 80,765         | 76,677         | 77,916         | 68,665         | 66,479         | 65,839         |
| U.K.         | 22,017           | 22,335         | 21,626         | 20,273         | 20,192         | 16,316         | 16,235         | 17,932         |
| Japan        | 35,825           | 34,335         | 28,646         | 24,722         | 23,153         | 20,017         | 20,234         | 21,934         |
| West Germany | 22,051           | 22,498         | 20,948         | 18,634         | 18,086         | 14,929         | 14,294         | 15,937         |
| France       | 15,393           | 14,575         | 14,630         | 13,286         | 13,139         | 11,426         | 11,509         | 12,065         |
| Others       | 102,988          | 98,799         | 91,260         | 82,804         | 83,086         | 69,741         | 69,698         | 69,153         |
| <b>TOTAL</b> | <b>370,609</b>   | <b>363,074</b> | <b>347,849</b> | <b>317,913</b> | <b>317,269</b> | <b>271,935</b> | <b>269,478</b> | <b>279,675</b> |

a "Origin" refers to the country in which the reported work was performed. Source: Chemical Abstracts Service

## ABSTRACTS OF PAPERS IN *CHEMICAL ABSTRACTS*: Biochemistry is leading category

| % IN EACH GROUP                                                      | 1979  | 1978  | 1977  | 1976  | 1975  | 1974  | 1973  | 1972  |
|----------------------------------------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|
| Biochemistry                                                         | 38.8% | 38.3% | 37.9% | 38.8% | 39.4% | 36.2% | 35.9% | 35.6% |
| Physical and analytical chemistry <sup>a</sup>                       | 28.9  | 27.4  | 27.9  | 27.5  | 29.6  | 29.7  | 31.0  | 32.2  |
| Applied chemistry and chemical engineering                           | 19.4  | 20.8  | 19.7  | 18.8  | 15.5  | 18.4  | 16.7  | 15.7  |
| Organic chemistry                                                    | 7.6   | 8.0   | 8.8   | 8.7   | 9.0   | 9.4   | 10.0  | 9.5   |
| Macromolecular chemistry                                             | 5.3   | 5.5   | 5.7   | 6.2   | 6.5   | 6.3   | 6.4   | 7.0   |
| <b>% OF ALL BIOCHEMISTRY ABSTRACTS</b>                               |       |       |       |       |       |       |       |       |
| Mammalian biochemistry                                               | 17.1% | 17.2% | 17.7% | 16.3% | 15.3% | 16.6% | 13.7% | 13.0% |
| Pharmacodynamics                                                     | 11.9  | 12.3  | 12.0  | 12.0  | 12.0  | 11.1  | 11.1  | 12.0  |
| Toxicology                                                           | 7.4   | 7.5   | 6.2   | 6.4   | 6.6   | 5.6   | 5.9   | 5.5   |
| General biochemistry                                                 | 7.0   | 6.5   | 7.0   | 7.1   | 7.5   | 7.3   | 7.9   | 7.4   |
| Enzymes                                                              | 6.4   | 5.7   | 6.1   | 6.4   | 7.4   | 6.4   | 5.8   | 6.6   |
| Others                                                               | 50.2  | 50.8  | 51.0  | 51.8  | 51.2  | 53.0  | 55.6  | 55.5  |
| <b>% OF ALL PHYSICAL AND ANALYTICAL CHEMISTRY ABSTRACTS</b>          |       |       |       |       |       |       |       |       |
| Nuclear chemistry                                                    | 25.1% | 20.7% | 21.1% | 19.7% | 20.0% | 15.8% | 19.0% | 18.1% |
| Spectra                                                              | 17.0  | 17.0  | 18.1  | 17.8  | 17.2  | 18.2  | 16.8  | 17.5  |
| Electric phenomena                                                   | 11.4  | 10.9  | 10.5  | 10.5  | 10.3  | 11.4  | 10.8  | 11.2  |
| Crystallization and crystal structure                                | 8.2   | 9.2   | 8.9   | 9.7   | 9.6   | 10.1  | 10.2  | 10.1  |
| General physical chemistry                                           | 6.6   | 6.6   | 6.8   | 7.0   | 6.8   | 6.4   | 7.2   | 6.9   |
| Analytical chemistry                                                 | 5.6   | 7.2   | 5.8   | 6.6   | 6.1   | 7.4   | 6.9   | 6.8   |
| Others                                                               | 25.8  | 26.4  | 28.8  | 28.7  | 30.0  | 30.7  | 29.1  | 29.4  |
| <b>% OF ALL APPLIED CHEMISTRY AND CHEMICAL ENGINEERING ABSTRACTS</b> |       |       |       |       |       |       |       |       |
| Metals and alloys                                                    | 23.6% | 24.0% | 24.2% | 27.8% | 24.4% | 27.9% | 24.2% | 26.6% |
| Water, wastes, and pollution                                         | 20.8  | 20.8  | 23.2  | 18.6  | 15.2  | 18.2  | 15.6  | 14.8  |
| Mineralogical and geological chemistry                               | 15.8  | 16.8  | 13.4  | 17.6  | 17.5  | 17.6  | 20.2  | 19.8  |
| Fossil fuels, derivatives, and related products                      | 7.8   | 8.2   | 9.2   | 6.0   | 9.8   | 4.0   | 8.0   | 7.3   |
| Unit operations and processes                                        | 6.1   | 6.4   | 5.8   | 4.8   | 5.3   | 5.6   | 7.8   | 7.0   |
| Others                                                               | 25.9  | 23.8  | 24.2  | 25.2  | 27.8  | 26.7  | 24.2  | 24.5  |
| <b>% OF ALL ORGANIC CHEMISTRY ABSTRACTS</b>                          |       |       |       |       |       |       |       |       |
| Physical organic chemistry                                           | 38.8% | 36.8% | 41.3% | 38.4% | 40.8% | 37.3% | 37.2% | 35.6% |
| Heterocyclic compounds                                               | 16.0  | 17.5  | 17.0  | 17.4  | 16.4  | 17.3  | 17.8  | 19.5  |
| Organometallic and organometalloid compounds                         | 8.5   | 8.9   | 8.5   | 8.7   | 8.4   | 8.2   | 7.8   | 8.6   |
| Aromatic compounds                                                   | 8.2   | 8.6   | 8.5   | 8.0   | 8.7   | 9.4   | 10.0  | 10.1  |
| Aliphatic compounds                                                  | 6.0   | 6.9   | 5.9   | 6.5   | 6.3   | 7.1   | 7.1   | 5.6   |
| Carbohydrates                                                        | 6.0   | 5.2   | 4.6   | 5.1   | 4.9   | 5.5   | 5.6   | 5.2   |
| Others                                                               | 16.5  | 16.1  | 14.2  | 15.9  | 14.5  | 15.2  | 14.5  | 15.4  |
| <b>% OF ALL MACROMOLECULAR CHEMISTRY ABSTRACTS</b>                   |       |       |       |       |       |       |       |       |
| Plastics manufacture and uses                                        | 27.8% | 28.1% | 27.5% | 26.8% | 23.3% | 23.1% | 24.9% | 24.0% |
| Synthetic high polymers                                              | 26.3  | 25.6  | 26.5  | 28.3  | 30.6  | 30.6  | 27.7  | 26.5  |
| Cellulose, lignin, paper, and other wood products                    | 11.1  | 10.6  | 10.0  | 9.1   | 9.2   | 9.2   | 9.8   | 9.2   |
| Textiles                                                             | 10.1  | 12.1  | 11.0  | 11.1  | 10.2  | 9.8   | 11.0  | 13.3  |
| Coatings, inks, and related products                                 | 8.1   | 7.5   | 7.5   | 7.6   | 7.3   | 8.1   | 8.1   | 7.7   |
| Elastomers, including natural rubber                                 | 7.6   | 8.0   | 8.5   | 8.6   | 9.2   | 10.4  | 9.2   | 9.7   |
| Others                                                               | 9.0   | 8.1   | 9.0   | 8.5   | 10.2  | 8.8   | 9.3   | 9.6   |

<sup>a</sup> Includes inorganic chemistry. Source: Chemical Abstracts Service

## U.S. PATENTS: Larger share goes to foreigners

|                      | 1979 <sup>a</sup> | 1978   | 1977   | 1976   | 1975   | 1974   | 1973   | 1972   | 1971   | 1970   | 1969   |
|----------------------|-------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| U.S. <sup>b</sup>    | 30,605            | 40,979 | 41,383 | 44,162 | 46,603 | 50,643 | 51,501 | 51,515 | 55,988 | 47,073 | 50,395 |
| Foreign <sup>c</sup> | 18,248            | 25,123 | 23,886 | 26,074 | 25,291 | 25,632 | 22,638 | 23,293 | 22,328 | 17,354 | 17,162 |
| TOTAL                | 48,853            | 66,102 | 65,269 | 70,236 | 71,994 | 76,275 | 74,139 | 74,808 | 78,316 | 64,427 | 67,557 |
| % Foreign            | 37.4%             | 38.0%  | 36.6%  | 37.1%  | 35.3%  | 33.6%  | 30.5%  | 31.1%  | 28.5%  | 26.9%  | 25.4%  |

<sup>a</sup> Patent figures were low in 1979 because the Patent & Trademark Office was short of funds to print patents it might otherwise have issued. <sup>b</sup> U.S. patents granted to U.S. residents. <sup>c</sup> U.S. patents granted to residents of foreign countries. Source: Patent & Trademark Office

## Federal R&D outlays to rise 4% this year

*Support of chemical research will be 11% higher, thanks largely to increases in energy and environmental projects*

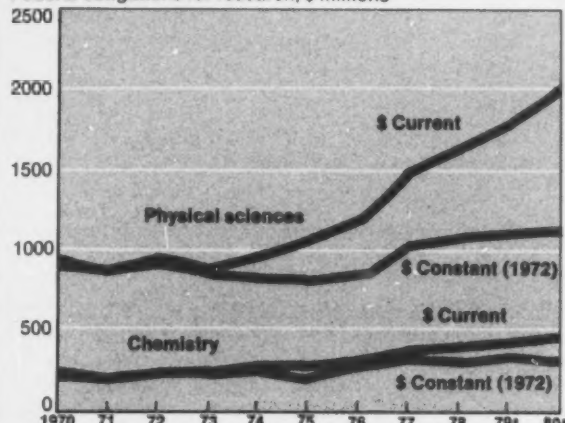
### FEDERAL OBLIGATIONS FOR R&D: Most funds go for defense, energy, space, and health

| Department or agency                                   | Total R&D (\$ millions) |                   |                   |                   |                      |
|--------------------------------------------------------|-------------------------|-------------------|-------------------|-------------------|----------------------|
|                                                        | 1980 <sup>a</sup>       | 1979 <sup>a</sup> | 1978              | 1977              | 1976                 |
| <b>Agriculture</b>                                     | \$ 663.7                | \$ 666.9          | \$ 621.3          | \$ 547.0          | \$ 462.4             |
| Science & Education Administration                     | 518.5                   | 518.4             | 483.0             | 426.2             | 355.5                |
| <b>Commerce</b>                                        | 321.9                   | 319.1             | 283.7             | 244.7             | 228.9                |
| National Bureau of Standards                           | 73.4                    | 70.2              | 58.3              | 53.2              | 47.4                 |
| <b>Defense</b>                                         | 13,879.7                | 13,001.5          | 11,553.6          | 10,963.4          | 9,654.7              |
| Army                                                   | 3,044.8                 | 2,775.6           | 2,548.9           | 2,441.9           | 2,013.7              |
| Navy                                                   | 4,527.9                 | 4,618.2           | 3,998.4           | 3,817.4           | 3,328.0              |
| Air Force                                              | 5,220.9                 | 4,679.1           | 4,262.3           | 4,031.1           | 3,726.6              |
| <b>Energy</b>                                          | 4,658.8                 | 4,688.5           | 4,244.8           | 3,536.2           | 2,498.9 <sup>b</sup> |
| <b>Health, Education &amp; Welfare</b>                 | 3,725.8                 | 3,665.4           | 3,207.3           | 2,787.3           | 2,545.9              |
| National Institutes of Health                          | 2,961.4                 | 2,960.6           | 2,580.9           | 2,243.9           | 2,022.6              |
| <b>Interior</b>                                        | 417.3                   | 435.0             | 385.2             | 296.3             | 314.2                |
| Geological Survey                                      | 178.2                   | 174.0             | 159.9             | 128.9             | 119.2                |
| <b>Environmental Protection Agency</b>                 | 435.6                   | 400.4             | 384.6             | 295.5             | 259.1                |
| <b>National Aeronautics &amp; Space Administration</b> | 4,540.0                 | 4,392.3           | 3,875.4           | 3,703.4           | 3,446.8              |
| <b>National Science Foundation</b>                     | 910.1                   | 818.9             | 748.8             | 697.0             | 609.3                |
| <b>Tennessee Valley Authority</b>                      | 64.0                    | 58.2              | 31.5              | 26.5              | 18.7                 |
| <b>Others</b>                                          | 1,116.0                 | 1,129.8           | 1,078.1           | 831.8             | 719.7                |
| <b>TOTAL</b>                                           | <b>\$30,732.9</b>       | <b>\$29,576.0</b> | <b>\$26,414.3</b> | <b>\$23,929.1</b> | <b>\$20,758.6</b>    |

Note: Fiscal years. a Estimated. b For Energy Research & Development Administration. Source: National Science Foundation

### Federal outlays for chemistry level off in constant dollars

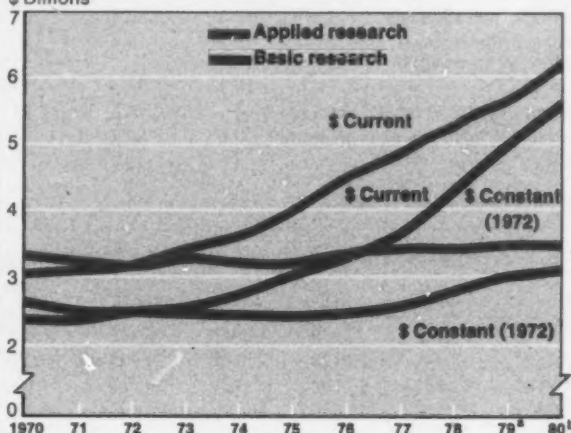
Federal obligations for research, \$ millions



a Estimates Note: Fiscal years. Source: National Science Foundation

### Federal support of basic research has outpaced inflation since 1975

\$ Billions



a Preliminary. b Estimates. Source: National Science Foundation

## FEDERAL OBLIGATIONS FOR RESEARCH: Health and defense get most support

| Department or agency, \$ millions                      | 1980 <sup>a</sup> |                  | 1979 <sup>a</sup> |                  | 1978           |                  | 1977           |                  | 1976               |                    |
|--------------------------------------------------------|-------------------|------------------|-------------------|------------------|----------------|------------------|----------------|------------------|--------------------|--------------------|
|                                                        | Basic research    | Applied research | Basic research    | Applied research | Basic research | Applied research | Basic research | Applied research | Basic research     | Applied research   |
| <b>Agriculture</b>                                     | \$ 267.6          | \$ 368.2         | \$ 251.9          | \$ 385.6         | \$ 242.7       | \$ 351.8         | \$ 204.5       | \$ 319.6         | \$ 171.4           | \$ 270.9           |
| Science & Education Administration                     | 232.0             | 263.5            | 214.7             | 279.6            | 207.9          | 253.2            | 174.0          | 234.3            | 144.8              | 196.2              |
| <b>Commerce</b>                                        | 28.8              | 199.4            | 26.8              | 189.6            | 23.9           | 168.9            | 23.2           | 153.0            | 22.3               | 133.4              |
| National Bureau of Standards                           | 10.7              | 46.8             | 8.6               | 45.1             | 5.9            | 42.6             | 6.9            | 38.0             | 5.8                | 31.7               |
| <b>Defense</b>                                         | 436.9             | 1975.7           | 378.4             | 1774.3           | 319.1          | 1622.1           | 294.8          | 1746.6           | 248.4              | 1539.3             |
| Army                                                   | 73.6              | 429.1            | 59.9              | 375.6            | 54.5           | 359.8            | 58.6           | 374.9            | 39.0               | 267.4              |
| Navy                                                   | 152.8             | 295.3            | 151.8             | 293.3            | 130.3          | 271.7            | 115.3          | 262.6            | 95.9               | 219.0              |
| Air Force                                              | 122.2             | 683.4            | 104.9             | 636.0            | 95.1           | 590.6            | 85.3           | 750.0            | 81.6               | 740.0              |
| <b>Energy</b>                                          | 548.4             | 719.5            | 471.6             | 711.5            | 440.5          | 661.7            | 389.5          | 501.8            | 345.8 <sup>b</sup> | 400.7 <sup>b</sup> |
| <b>Health, Education &amp; Welfare</b>                 | 1581.5            | 1635.9           | 1561.4            | 1580.1           | 1292.3         | 1448.4           | 757.2          | 1676.5           | 652.4              | 1510.5             |
| National Institutes of Health                          | 1434.5            | 1132.4           | 1428.6            | 1133.2           | 1181.1         | 1051.5           | 670.5          | 1317.6           | 586.6              | 1193.3             |
| <b>Interior</b>                                        | 161.4             | 208.0            | 165.4             | 209.3            | 145.7          | 164.1            | 128.9          | 108.6            | 113.3              | 127.2              |
| Geological Survey                                      | 137.3             | 40.8             | 138.0             | 36.1             | 126.1          | 33.8             | 105.6          | 23.3             | 98.5               | 20.7               |
| <b>Environmental Protection Agency</b>                 | 16.9              | 297.4            | 9.4               | 257.8            | 6.0            | 246.7            | 8.3            | 197.0            | 13.7               | 141.7              |
| <b>National Aeronautics &amp; Space Administration</b> | 599.2             | 1037.8           | 531.2             | 963.9            | 479.7          | 865.4            | 413.8          | 792.3            | 293.2              | 929.6              |
| <b>National Science Foundation</b>                     | 828.3             | 72.8             | 741.1             | 70.0             | 678.0          | 65.5             | 624.9          | 63.4             | 523.6              | 72.1               |
| <b>Tennessee Valley Authority</b>                      | 4.3               | 20.2             | 4.0               | 19.4             | 3.8            | 9.7              | 3.5            | 19.3             | —                  | 16.5               |
| <b>Others</b>                                          | 64.3              | 520.8            | 64.1              | 522.6            | 67.4           | 447.5            | 45.5           | 389.0            | 41.4               | 305.9              |
| <b>TOTAL</b>                                           | \$4537.6          | \$7055.7         | \$4205.1          | \$6684.1         | \$3699.1       | \$6051.8         | \$2894.1       | \$5947.1         | \$2425.5           | \$5447.8           |

Note: Fiscal years. a Estimated. b For Energy Research & Development Administration. Source: National Science Foundation

## FEDERAL OBLIGATIONS FOR SCIENTIFIC DISCIPLINES: A third go to life sciences

| \$ Millions for research only            | 1980 <sup>a</sup> | 1979 <sup>a</sup> | 1978     | 1977     | 1976     | Annual change |         |
|------------------------------------------|-------------------|-------------------|----------|----------|----------|---------------|---------|
|                                          |                   |                   |          |          |          | 1979-80       | 1978-79 |
| <b>Physical sciences</b>                 | \$ 2,064          | \$ 1,847          | \$ 1,683 | \$ 1,511 | \$ 1,221 | 12%           | 14%     |
| Chemistry                                | 479               | 432               | 416      | 411      | 325      | 11            | 10      |
| Physics                                  | 1,148             | 1,069             | 965      | 841      | 679      | 7             | 14      |
| <b>Life sciences</b>                     | 3,093             | 3,896             | 3,430    | 3,019    | 2,648    | 2             | 11      |
| <b>Environmental sciences</b>            | 1,289             | 1,180             | 1,050    | 921      | 770      | 9             | 14      |
| <b>Mathematics and computer sciences</b> | 316               | 276               | 236      | 176      | 153      | 14            | 20      |
| <b>Engineering</b>                       | 2,795             | 2,659             | 2,446    | 2,426    | 2,378    | 5             | 4       |
| Chemical                                 | 154               | 137               | 153      | 107      | 91       | 12            | 14      |
| Metallurgy and materials                 | 327               | 324               | 295      | 314      | 296      | 1             | 3       |
| <b>Other sciences</b>                    | 1,136             | 1,031             | 906      | 788      | 705      | 10            | 13      |
| <b>TOTAL</b>                             | \$11,593          | \$10,889          | \$9,751  | \$8,841  | \$7,873  | 6%            | 10%     |

Note: Fiscal years. a Estimated. Source: National Science Foundation

## FEDERAL OBLIGATIONS FOR DEVELOPMENT: Department of Defense supplies most money

| Department or agency                                   | Development (\$ millions) |                   |            |            |                      |
|--------------------------------------------------------|---------------------------|-------------------|------------|------------|----------------------|
|                                                        | 1980 <sup>a</sup>         | 1979 <sup>a</sup> | 1978       | 1977       | 1976                 |
| <b>Agriculture</b>                                     | \$ 27.9                   | \$ 29.4           | \$ 26.8    | \$ 22.9    | \$ 20.2              |
| Science & Education Administration                     | 23.0                      | 24.1              | 21.8       | 18.0       | 14.5                 |
| <b>Commerce</b>                                        | 93.7                      | 102.9             | 90.9       | 68.6       | 73.1                 |
| National Bureau of Standards                           | 16.0                      | 16.5              | 9.8        | 8.3        | 9.9                  |
| <b>Defense</b>                                         | 11,467.2                  | 10,848.8          | 9,612.4    | 8,922.0    | 7,867.0              |
| Army                                                   | 2,542.1                   | 2,340.1           | 2,134.6    | 2,008.5    | 1,707.2              |
| Navy                                                   | 4,079.8                   | 4,173.1           | 3,596.4    | 3,439.4    | 3,013.1              |
| Air Force                                              | 4,415.3                   | 3,938.2           | 3,576.6    | 3,195.8    | 2,905.0              |
| <b>Energy</b>                                          | 3,390.9                   | 3,505.3           | 3,142.6    | 2,645.0    | 1,752.4 <sup>b</sup> |
| <b>Health, Education &amp; Welfare</b>                 | 508.4                     | 523.9             | 466.5      | 353.6      | 383.0                |
| National Institutes of Health                          | 394.5                     | 398.8             | 348.3      | 255.8      | 242.7                |
| <b>Interior</b>                                        | 47.9                      | 60.3              | 75.5       | 58.7       | 73.7                 |
| <b>Environmental Protection Agency</b>                 | 121.3                     | 133.1             | 132.0      | 90.2       | 103.7                |
| <b>National Aeronautics &amp; Space Administration</b> | 2,903.0                   | 2,897.2           | 2,530.2    | 2,497.3    | 2,224.0              |
| <b>National Science Foundation</b>                     | 9.0                       | 7.9               | 5.3        | 8.7        | 13.5                 |
| <b>Tennessee Valley Authority</b>                      | 39.5                      | 34.8              | 18.0       | 3.6        | 2.2                  |
| <b>Others</b>                                          | 530.8                     | 543.2             | 563.2      | 417.3      | 372.5                |
| <b>TOTAL</b>                                           | \$19,139.6                | \$18,686.8        | \$16,663.4 | \$15,087.9 | \$12,865.3           |

Note: Fiscal years. a Estimated. b For Energy Research & Development Administration. Source: National Science Foundation

## OBLIGATIONS FOR PHYSICAL SCIENCES: Chemistry gets biggest support for energy work

| Department or agency                                   | Federal obligations (\$ millions) |                |                   |                |                   |                |                   |                |                    |                   |
|--------------------------------------------------------|-----------------------------------|----------------|-------------------|----------------|-------------------|----------------|-------------------|----------------|--------------------|-------------------|
|                                                        | 1980 <sup>a</sup>                 |                | 1979 <sup>a</sup> |                | 1978              |                | 1977              |                | 1976               |                   |
|                                                        | Physical sciences                 | Chemistry      | Physical sciences | Chemistry      | Physical sciences | Chemistry      | Physical sciences | Chemistry      | Physical sciences  | Chemistry         |
| <b>Agriculture</b>                                     | \$ 50.5                           | \$ 46.1        | \$ 51.6           | \$ 47.0        | \$ 52.1           | \$ 47.8        | \$ 63.4           | \$ 53.8        | \$ 53.1            | \$ 44.9           |
| Science & Education Administration                     | 45.5                              | 42.7           | 46.2              | 43.4           | 47.1              | 44.4           | 58.6              | 50.9           | 48.6               | 42.5              |
| <b>Commerce</b>                                        | 41.3                              | 10.8           | 37.3              | 9.2            | 32.5              | 8.2            | 27.8              | 9.5            | 22.8               | 7.1               |
| National Bureau of Standards                           | 35.8                              | 9.6            | 31.1              | 7.9            | 27.5              | 7.1            | 24.7              | 7.8            | 22.8               | 7.1               |
| <b>Defense</b>                                         | 452.3                             | 78.7           | 401.3             | 78.0           | 358.4             | 71.3           | 289.3             | 90.9           | 210.6              | 46.9              |
| Army                                                   | 98.4                              | 35.2           | 91.2              | 36.5           | 84.2              | 30.1           | 82.9              | 62.5           | 57.7               | 25.6              |
| Navy                                                   | 108.4                             | 16.9           | 108.7             | 16.9           | 100.6             | 17.8           | 95.3              | 15.3           | 71.7               | 11.1              |
| Air Force                                              | 106.0                             | 26.3           | 107.4             | 23.8           | 94.4              | 22.7           | 30.9              | 11.8           | 27.7               | 9.3               |
| <b>Energy</b>                                          | 717.2                             | 89.4           | 650.7             | 70.6           | 615.8             | 76.1           | 552.8             | 76.3           | 475.4 <sup>b</sup> | 76.5 <sup>b</sup> |
| <b>Health, Education &amp; Welfare</b>                 | 67.0                              | 60.3           | 66.6              | 59.9           | 58.3              | 52.5           | 54.0              | 49.3           | 44.6               | 43.1              |
| National Institutes of Health                          | 65.9                              | 59.2           | 65.8              | 59.1           | 57.1              | 51.2           | 53.1              | 48.3           | 44.5               | 43.0              |
| <b>Interior</b>                                        | 22.2                              | 17.9           | 19.6              | 15.4           | 18.9              | 15.2           | 13.8              | 11.2           | 11.5               | 9.7               |
| Geological Survey                                      | 15.4                              | 12.9           | 11.5              | 9.0            | 13.2              | 11.1           | 9.4               | 7.9            | 9.0                | 7.5               |
| <b>Environmental Protection Agency</b>                 | 92.2                              | 86.5           | 74.8              | 70.0           | 70.7              | 67.8           | 50.2              | 46.0           | 49.7               | 45.7              |
| <b>National Aeronautics &amp; Space Administration</b> | 362.1                             | 8.0            | 310.0             | 7.5            | 264.8             | 9.3            | 264.2             | 11.8           | 197.1              | 5.3               |
| <b>National Science Foundation</b>                     | 241.3                             | 74.2           | 219.7             | 66.2           | 195.7             | 60.3           | 184.2             | 57.7           | 148.0              | 43.1              |
| <b>Tennessee Valley Authority</b>                      | 6.2                               | 6.2            | 6.0               | 6.0            | 5.4               | 5.4            | 4.4               | 4.4            | 1.8                | 1.8               |
| <b>Others</b>                                          | 11.3                              | 1.3            | 12.3              | 1.9            | 10.8              | 1.7            | 6.5               | 0.3            | 6.0                | 0.5               |
| <b>TOTAL</b>                                           | <b>\$2065.6</b>                   | <b>\$479.4</b> | <b>\$1846.9</b>   | <b>\$431.7</b> | <b>\$1683.4</b>   | <b>\$415.6</b> | <b>\$1510.6</b>   | <b>\$411.2</b> | <b>\$1220.6</b>    | <b>\$324.6</b>    |

Note: Fiscal years. a Estimated. b For Energy Research & Development Administration. Source: National Science Foundation

## BASIC RESEARCH: NSF is biggest backer of basic chemistry

| Department or agency                                   | Federal obligations (\$ millions) |                |                   |                |                   |                |                   |                |                    |                   |
|--------------------------------------------------------|-----------------------------------|----------------|-------------------|----------------|-------------------|----------------|-------------------|----------------|--------------------|-------------------|
|                                                        | 1980 <sup>a</sup>                 |                | 1979 <sup>a</sup> |                | 1978              |                | 1977              |                | 1976               |                   |
|                                                        | Physical sciences                 | Chemistry      | Physical sciences | Chemistry      | Physical sciences | Chemistry      | Physical sciences | Chemistry      | Physical sciences  | Chemistry         |
| <b>Agriculture</b>                                     | \$ 24.6                           | \$ 22.7        | \$ 24.1           | \$ 22.2        | \$ 25.4           | \$ 23.6        | \$ 27.5           | \$ 23.9        | \$ 21.5            | \$ 18.5           |
| Science & Education Administration                     | 22.4                              | 21.0           | 21.8              | 20.5           | 23.2              | 21.9           | 25.5              | 22.6           | 19.6               | 17.3              |
| <b>Commerce</b>                                        | 11.0                              | 1.9            | 8.8               | 1.6            | 6.6               | 1.0            | 8.2               | 2.8            | 4.8                | 1.3               |
| National Bureau of Standards                           | 9.9                               | 1.8            | 7.8               | 1.4            | 5.7               | 0.9            | 5.7               | 1.6            | 4.8                | 1.3               |
| <b>Defense</b>                                         | 109.9                             | 26.2           | 91.5              | 23.2           | 73.1              | 20.9           | 72.2              | 25.3           | 52.2               | 12.9              |
| Army                                                   | 12.7                              | 5.1            | 10.0              | 4.0            | 9.3               | 3.7            | 14.2              | 9.6            | 5.2                | 2.5               |
| Navy                                                   | 43.2                              | 9.7            | 43.0              | 9.7            | 37.9              | 8.2            | 33.1              | 7.2            | 28.0               | 5.1               |
| Air Force                                              | 26.3                              | 11.3           | 23.3              | 9.2            | 22.5              | 9.0            | 21.2              | 8.4            | 16.4               | 5.3               |
| <b>Energy</b>                                          | 384.6                             | 64.4           | 345.0             | 53.4           | 325.4             | 47.9           | 293.8             | 61.7           | 267.4 <sup>b</sup> | 53.8 <sup>b</sup> |
| <b>Health, Education &amp; Welfare</b>                 | 40.1                              | 36.3           | 39.8              | 36.0           | 32.9              | 29.6           | 35.3              | 33.6           | 33.6               | 33.3              |
| National Institutes of Health                          | 39.7                              | 36.0           | 39.6              | 35.8           | 32.7              | 29.6           | 34.4              | 32.7           | 33.5               | 33.3              |
| <b>Interior</b>                                        | 13.8                              | 10.7           | 15.4              | 12.3           | 12.9              | 10.2           | 9.4               | 7.4            | 7.3                | 6.1               |
| Geological Survey                                      | 8.5                               | 7.0            | 8.8               | 7.4            | 8.9               | 7.7            | 6.8               | 5.8            | 6.3                | 5.3               |
| <b>Environmental Protection Agency</b>                 | 5.2                               | 4.5            | 2.8               | 2.2            | 1.7               | 1.3            | 1.5               | 1.1            | 4.1                | 3.8               |
| <b>National Aeronautics &amp; Space Administration</b> | 333.5                             | 7.7            | 283.0             | 7.2            | 243.1             | 8.9            | 239.6             | 10.3           | 182.9              | 4.7               |
| <b>National Science Foundation</b>                     | 233.7                             | 70.1           | 208.6             | 61.1           | 189.8             | 56.7           | 179.2             | 54.4           | 143.5              | 40.6              |
| <b>Tennessee Valley Authority</b>                      | 2.6                               | 2.6            | 2.5               | 2.5            | 2.4               | 2.4            | 2.3               | 2.3            | —                  | —                 |
| <b>Others</b>                                          | 9.5                               | 1.0            | 10.1              | 1.5            | 6.1               | 1.5            | 4.8               | 0.2            | 4.3                | 0.1               |
| <b>TOTAL</b>                                           | <b>\$1168.5</b>                   | <b>\$248.1</b> | <b>\$1031.4</b>   | <b>\$223.2</b> | <b>\$922.4</b>    | <b>\$204.2</b> | <b>\$873.8</b>    | <b>\$223.0</b> | <b>\$721.6</b>     | <b>\$175.1</b>    |

Note: Fiscal years. a Estimated. b For Energy Research & Development Administration. Source: National Science Foundation

## APPLIED RESEARCH: Most growth for chemistry comes in environmental and energy work

| Department or agency                                   | Federal obligations (\$ millions) |                |                   |                |                   |                |                   |                |                    |                   |
|--------------------------------------------------------|-----------------------------------|----------------|-------------------|----------------|-------------------|----------------|-------------------|----------------|--------------------|-------------------|
|                                                        | 1980 <sup>a</sup>                 |                | 1979 <sup>a</sup> |                | 1978              |                | 1977              |                | 1976               |                   |
|                                                        | Physical sciences                 | Chemistry      | Physical sciences | Chemistry      | Physical sciences | Chemistry      | Physical sciences | Chemistry      | Physical sciences  | Chemistry         |
| <b>Agriculture</b>                                     | \$ 25.9                           | \$ 23.4        | \$ 27.4           | \$ 24.8        | \$ 26.7           | \$ 24.3        | \$ 36.0           | \$ 29.9        | \$ 31.6            | \$ 26.4           |
| Science & Education Administration                     | 23.1                              | 21.7           | 24.4              | 22.9           | 23.8              | 22.5           | 33.1              | 28.4           | 29.0               | 25.2              |
| <b>Commerce</b>                                        | 30.3                              | 8.8            | 28.4              | 7.7            | 25.9              | 7.2            | 19.6              | 6.7            | 18.0               | 5.8               |
| National Bureau of Standards                           | 25.9                              | 7.8            | 23.3              | 6.5            | 21.8              | 6.2            | 19.0              | 6.1            | 18.0               | 5.8               |
| <b>Defense</b>                                         | 342.5                             | 52.5           | 309.9             | 54.8           | 285.3             | 50.4           | 217.2             | 65.6           | 158.4              | 34.0              |
| Army                                                   | 85.7                              | 30.0           | 81.2              | 32.5           | 74.9              | 26.3           | 68.7              | 53.0           | 52.5               | 23.1              |
| Navy                                                   | 65.2                              | 7.1            | 65.7              | 7.1            | 62.7              | 9.6            | 62.1              | 8.1            | 43.7               | 6.0               |
| Air Force                                              | 79.7                              | 15.0           | 84.0              | 14.6           | 71.9              | 13.8           | 9.7               | 3.4            | 11.3               | 4.0               |
| <b>Energy</b>                                          | 332.5                             | 24.9           | 305.7             | 17.2           | 290.5             | 28.2           | 258.9             | 14.6           | 208.0 <sup>b</sup> | 22.7 <sup>b</sup> |
| <b>Health, Education &amp; Welfare</b>                 | 26.9                              | 24.0           | 26.8              | 23.9           | 25.4              | 22.6           | 18.7              | 15.6           | 11.1               | 9.8               |
| National Institutes of Health                          | 26.2                              | 23.3           | 26.2              | 23.3           | 24.3              | 21.6           | 18.7              | 15.6           | 11.0               | 9.7               |
| <b>Interior</b>                                        | 8.4                               | 7.2            | 4.2               | 3.1            | 6.0               | 5.0            | 4.4               | 3.6            | 4.2                | 3.6               |
| Geological Survey                                      | 6.9                               | 5.9            | 2.6               | 1.6            | 4.3               | 3.4            | 2.7               | 2.1            | 2.7                | 2.2               |
| <b>Environmental Protection Agency</b>                 | 87.0                              | 82.0           | 72.2              | 67.8           | 69.1              | 66.4           | 48.7              | 45.0           | 45.6               | 42.0              |
| <b>National Aeronautics &amp; Space Administration</b> | 28.6                              | 0.3            | 27.0              | 0.3            | 21.7              | 0.3            | 24.6              | 1.4            | 14.2               | 0.5               |
| <b>National Science Foundation</b>                     | 7.5                               | 4.1            | 8.1               | 5.0            | 5.9               | 3.6            | 5.0               | 3.3            | 4.6                | 2.5               |
| <b>Tennessee Valley Authority</b>                      | 3.6                               | 3.6            | 3.5               | 3.5            | 3.0               | 3.0            | 2.1               | 2.1            | 1.8                | 1.8               |
| <b>Others</b>                                          | 1.9                               | 0.5            | 2.3               | 0.4            | 1.5               | 0.4            | 1.5               | 0.2            | 1.5                | 0.4               |
| <b>TOTAL</b>                                           | <b>\$895.1</b>                    | <b>\$231.3</b> | <b>\$815.5</b>    | <b>\$208.5</b> | <b>\$761.0</b>    | <b>\$211.4</b> | <b>\$636.7</b>    | <b>\$188.2</b> | <b>\$499.0</b>     | <b>\$149.5</b>    |

Note: Fiscal years. <sup>a</sup> Estimated. <sup>b</sup> For Energy Research & Development Administration. Source: National Science Foundation

## UNIVERSITY RESEARCH: Main federal emphasis is on life sciences

| Federal obligations, \$ millions         | 1980 <sup>a</sup> | 1979 <sup>a</sup> | 1978            | 1977            | 1976            | 1975            | 1974            | Annual change |            |
|------------------------------------------|-------------------|-------------------|-----------------|-----------------|-----------------|-----------------|-----------------|---------------|------------|
|                                          |                   |                   |                 |                 |                 |                 |                 | 1979-80       | 1974-80    |
| <b>Physical sciences</b>                 | \$ 440.9          | \$ 407.2          | \$ 366.2        | \$ 323.8        | \$ 281.3        | \$ 270.6        | \$ 244.4        | 8%            | 10%        |
| Chemistry                                | 153.2             | 138.8             | 122.8           | 117.1           | 99.1            | 95.0            | 79.4            | 10            | 12         |
| Physics                                  | 235.8             | 220.8             | 198.9           | 163.5           | 147.2           | 141.7           | 128.7           | 7             | 11         |
| <b>Life sciences</b>                     | 1897.0            | 1852.4            | 1606.1          | 1405.2          | 1233.6          | 1140.4          | 1103.5          | 2             | 9          |
| <b>Environmental sciences</b>            | 272.9             | 251.1             | 225.7           | 205.7           | 170.7           | 147.8           | 131.8           | 9             | 13         |
| <b>Mathematics and computer sciences</b> | 100.2             | 90.8              | 78.9            | 69.8            | 67.0            | 64.6            | 58.2            | 10            | 10         |
| <b>Engineering</b>                       | 287.6             | 264.4             | 247.0           | 249.3           | 191.9           | 188.8           | 157.3           | 9             | 11         |
| Chemical                                 | 24.6              | 22.6              | 27.0            | 17.5            | 16.3            | 15.9            | 9.9             | 9             | 16         |
| Metallurgy and materials                 | 62.6              | 56.6              | 48.6            | 48.0            | 46.0            | 43.5            | 35.3            | 11            | 10         |
| <b>Other sciences</b>                    | 295.5             | 279.8             | 252.3           | 228.4           | 227.5           | 185.8           | 187.1           | 6             | 8          |
| <b>TOTAL</b>                             | <b>\$3294.1</b>   | <b>\$3145.7</b>   | <b>\$2776.2</b> | <b>\$2482.2</b> | <b>\$2172.0</b> | <b>\$1998.0</b> | <b>\$1882.3</b> | <b>5%</b>     | <b>10%</b> |

Note: Fiscal years. <sup>a</sup> Estimated. Source: National Science Foundation

## UNIVERSITY BASIC RESEARCH: Federal funding for chemistry will grow 14% this year

| Federal obligations, \$ millions         | 1980 <sup>a</sup> | 1979 <sup>a</sup> | 1978            | 1977            | 1976            | 1975            | 1974           | Annual change |            |
|------------------------------------------|-------------------|-------------------|-----------------|-----------------|-----------------|-----------------|----------------|---------------|------------|
|                                          |                   |                   |                 |                 |                 |                 |                | 1979-80       | 1974-80    |
| <b>Physical sciences</b>                 | \$ 371.1          | \$ 331.5          | \$ 296.9        | \$ 273.8        | \$ 243.1        | \$ 234.8        | \$211.9        | 12%           | 10%        |
| Chemistry                                | 130.2             | 113.9             | 100.9           | 101.7           | 88.1            | 82.6            | 67.5           | 14            | 12         |
| Physics                                  | 192.8             | 174.3             | 155.8           | 135.7           | 125.2           | 121.8           | 112.7          | 11            | 9          |
| <b>Life sciences</b>                     | 1164.7            | 1120.8            | 925.9           | 571.1           | 508.0           | 455.2           | 434.0          | 4             | 18         |
| <b>Environmental sciences</b>            | 232.3             | 211.0             | 190.2           | 185.6           | 127.6           | 119.1           | 103.8          | 10            | 14         |
| <b>Mathematics and computer sciences</b> | 81.2              | 71.7              | 63.7            | 55.7            | 46.1            | 42.1            | 36.5           | 13            | 14         |
| <b>Engineering</b>                       | 186.9             | 165.3             | 147.1           | 134.1           | 109.8           | 102.8           | 83.6           | 13            | 14         |
| Chemical                                 | 11.9              | 10.3              | 9.4             | 9.5             | 10.2            | 10.8            | 6.4            | 16            | 11         |
| Metallurgy and materials                 | 57.6              | 50.2              | 42.9            | 41.2            | 34.9            | 32.6            | 27.4           | 15            | 13         |
| <b>Other sciences</b>                    | 134.1             | 119.6             | 102.3           | 91.6            | 78.3            | 77.7            | 78.9           | 12            | 9          |
| <b>TOTAL</b>                             | <b>\$2170.3</b>   | <b>\$2019.9</b>   | <b>\$1726.1</b> | <b>\$1291.9</b> | <b>\$1112.9</b> | <b>\$1031.7</b> | <b>\$948.7</b> | <b>7%</b>     | <b>15%</b> |

Note: Fiscal years. <sup>a</sup> Estimated. Source: National Science Foundation

# Federal agencies will have higher R&D budgets next year, with Defense the biggest gainer

## DEPARTMENT OF ENERGY R&D BUDGET: Solar energy comes up fast

| \$ millions                | 1981                                                    |                                      | 1980 <sup>b</sup> | 1979           | 1978           | % change<br>1980-81 <sup>c</sup> |
|----------------------------|---------------------------------------------------------|--------------------------------------|-------------------|----------------|----------------|----------------------------------|
|                            | Probable<br>Congressional<br>authorization <sup>a</sup> | Revised<br>Administration<br>request |                   |                |                |                                  |
| Nuclear                    | \$ 824.3                                                | \$ 855.0                             | \$ 894.3          | \$ 838.0       | \$ 880.8       | 7%                               |
| Fossil energy              | 749.8                                                   | 653.1                                | 741.5             | 725.4          | 676.2          | 1                                |
| Solar technology           | 422.7                                                   | 414.5                                | 335.0             | 302.7          | 216.4          | 20                               |
| Conservation               | 363.6                                                   | 295.0                                | 317.1             | 276.1          | 198.3          | 15                               |
| Magnetic fusion            | 277.3                                                   | 281.3                                | 228.1             | 219.9          | 203.9          | 21                               |
| Environmental R&D          | 272.5                                                   | 261.3                                | 255.7             | 205.3          | 242.5          | 6                                |
| General sciences, research | 239.9                                                   | 242.2                                | 217.8             | 193.4          | 257.1          | 18                               |
| Basic energy sciences      | 221.0                                                   | 229.5                                | 196.1             | 173.0          | 186.1          | 13                               |
| Materials sciences         | 88.1                                                    | 90.4                                 | 79.0              | 71.5           | 66.7           | 11                               |
| Chemical sciences          | 60.4                                                    | 61.2                                 | 55.1              | 48.0           | 43.3           | 10                               |
| Nuclear sciences           | 33.1                                                    | 33.4                                 | 30.7              | 26.1           | 26.1           | 6                                |
| Other                      | 40.2                                                    | 44.5                                 | 31.3              | 25.4           | 20.0           | 25                               |
| Geothermal                 | 127.3                                                   | 141.2                                | 121.7             | 116.1          | 103.7          | 5                                |
| Energy storage systems     | 72.8                                                    | 70.1                                 | 84.1              | 58.9           | 48.5           | 13                               |
| <b>TOTAL</b>               | <b>\$972.0</b>                                          | <b>\$922.7</b>                       | <b>\$831.8</b>    | <b>\$783.0</b> | <b>\$794.3</b> | <b>10%</b>                       |

Note: Fiscal years. a. C&EN estimate based on recent Senate and House action. b. Estimate. c. Based on probable Congressional authorization.

## NSF BUDGET: A billion dollars for scientific research this year

| \$ millions                                          | 1981                                                    |                                      | 1980 <sup>b</sup> | 1979           | 1978                  | % change<br>1980-81 <sup>c</sup> |
|------------------------------------------------------|---------------------------------------------------------|--------------------------------------|-------------------|----------------|-----------------------|----------------------------------|
|                                                      | Probable<br>Congressional<br>authorization <sup>a</sup> | Revised<br>Administration<br>request |                   |                |                       |                                  |
| Mathematical and physical sciences                   | \$ 252.5                                                | \$ 259.8                             | \$ 226.4          | \$ 208.0       | \$ 248.5 <sup>d</sup> | 11%                              |
| Astronomical, atmospheric, earth, and ocean sciences | 230.7                                                   | 235.8                                | 217.8             | 211.8          | 211.8                 | 6                                |
| Biological, behavioral, and social sciences          | 180.5                                                   | 177.8                                | 168.5             | 154.7          | 141.8                 | 8                                |
| Engineering and applied sciences                     | 135.3                                                   | 119.6                                | 111.8             | 109.9          | 55.1                  | 21                               |
| Science education                                    | 89.8                                                    | 75.7                                 | 75.7              | 80.0           | 73.9                  | 18                               |
| Program development and management                   | 59.9                                                    | 59.8                                 | 60.8              | 54.8           | 48.7                  | -1                               |
| Antarctic program                                    | 59.7                                                    | 60.4                                 | 55.8              | 51.1           | 43.5                  | 7                                |
| Cross directorate programs                           | 33.0                                                    | 29.7                                 | 25.5              | 16.9           | —                     | 20                               |
| Scientific, technological, and international affairs | 28.5                                                    | 27.7                                 | 24.1              | 23.7           | 28.8                  | 18                               |
| Ocean drilling programs                              | 20.7                                                    | 22.0                                 | 19.5              | 11.8           | —                     | 6                                |
| Women in Science programs                            | 7.7                                                     | —                                    | —                 | —              | —                     | —                                |
| Special foreign currency program                     | 5.5                                                     | 5.5                                  | 5.5               | 4.0            | 5.4                   | 0                                |
| <b>TOTAL</b>                                         | <b>\$1193.8</b>                                         | <b>\$1073.8</b>                      | <b>\$968.3</b>    | <b>\$927.2</b> | <b>\$957.4</b>        | <b>11%</b>                       |

Note: Fiscal years. a. C&EN estimates based on recent Senate and House action. b. Estimate. c. Based on probable Congressional authorization. d. Includes engineering programs.

## DEFENSE R&D BUDGET: Air Force outlays due for a big increase

| \$ millions         | 1981                                                    |                                      | 1980 <sup>b</sup> | 1979              | 1978              | % change<br>1980-81 <sup>c</sup> |
|---------------------|---------------------------------------------------------|--------------------------------------|-------------------|-------------------|-------------------|----------------------------------|
|                     | Probable<br>Congressional<br>authorization <sup>a</sup> | Revised<br>Administration<br>request |                   |                   |                   |                                  |
| Air Force           | \$ 7,137.9                                              | \$ 7,033.4                           | \$ 4,588.4        | \$ 4,358.0        | \$ 4,222.0        | 43%                              |
| Navy                | 5,113.9                                                 | 4,865.6                              | 4,584.5           | 4,464.4           | 4,054.3           | 12                               |
| Army                | 3,216.0                                                 | 3,234.5                              | 2,851.2           | 2,838.9           | 2,418.3           | 13                               |
| Defense agencies    | 1,307.1                                                 | 1,302.7                              | 1,037.0           | 892.9             | 754.3             | 28                               |
| Test and evaluation | 42.1                                                    | 42.1                                 | 42.5              | 27.8              | 25.0              | -1                               |
| <b>TOTAL</b>        | <b>\$16,817.0</b>                                       | <b>\$16,478.3</b>                    | <b>\$13,446.8</b> | <b>\$12,382.7</b> | <b>\$11,473.9</b> | <b>28%</b>                       |

Note: Fiscal years. a. C&EN estimates based on recent Senate and House action. b. Estimate. c. Based on probable Congressional authorization.

## NASA R&D BUDGET: Space shuttle gets largest share but no increase

| Agency                               | 1981                        |                                  | 1980 <sup>a</sup> | 1979     | 1978     | % change<br>1980-81 <sup>b</sup> |
|--------------------------------------|-----------------------------|----------------------------------|-------------------|----------|----------|----------------------------------|
|                                      | Congressional authorization | Executive Administration request |                   |          |          |                                  |
| Conduct of R&D                       | \$4496.7                    | \$4964.5                         | \$4992.5          | \$3477.2 | \$3911.3 | 8%                               |
| Space shuttle                        | 1873.0                      | 1873.0                           | 1871.0            | 1638.3   | 1349.2   | 0.1                              |
| Space flight operations              | 779.5                       | 767.5                            | 446.6             | 299.7    | 267.9    | 74                               |
| Space applications                   | 376.7                       | 368.7                            | 354.3             | 295.2    | 234.2    | 4                                |
| Physics and astronomy                | 362.7                       | 348.6                            | 339.2             | 306.5    | 224.2    | 4                                |
| Tracking and data acquisition        | 349.7                       | 349.0                            | 332.4             | 289.9    | 276.3    | 6                                |
| Aeronautical research and technology | 290.8                       | 275.3                            | 306.3             | 284.1    | 228.0    | -6                               |
| Planetary exploration                | 179.6                       | 176.3                            | 219.9             | 183.4    | 147.2    | -18                              |
| Space research & technology          | 115.2                       | 110.2                            | 115.8             | 107.3    | 97.7     | -1                               |
| Expendable launch vehicles           | 65.7                        | 55.7                             | 36.1              | 36.7     | 194.5    | 64                               |
| Life sciences                        | 45.2                        | 39.1                             | 43.8              | 40.1     | 38.3     | 3                                |
| Technology utilization               | 12.6                        | 12.1                             | 12.1              | 9.1      | 9.1      | 4                                |
| Energy technology                    | 4.0                         | 4.0                              | 3.0               | 5.0      | 7.5      | 23                               |
| Research and program management      | 1033.1                      | 1033.1                           | 996.2             | 933.6    | 889.6    | 4                                |
| Construction of facilities           | 118.9                       | 128.9                            | 156.1             | 147.5    | 162.3    | -26                              |
| TOTAL                                | \$5567.9                    | \$5517.5                         | \$5244.5          | \$4855.5 | \$4992.4 | 6%                               |

Note: Fiscal years. <sup>a</sup> Estimate.

## EPA R&D BUDGET: Overall change will be modest in fiscal 1981

| Agency            | 1981                                              |                        | 1980 <sup>a</sup> | 1979    | 1978    | % change<br>1980-81 <sup>b</sup> |
|-------------------|---------------------------------------------------|------------------------|-------------------|---------|---------|----------------------------------|
|                   | Probable Congressional authorization <sup>c</sup> | Administration request |                   |         |         |                                  |
| Energy            | \$105.1                                           | \$107.6                | \$101.4           | \$112.6 | \$133.1 | 4%                               |
| Air               | 70.2                                              | 70.2                   | 66.7              | 52.0    | 44.5    | 6                                |
| Water quality     | 64.0                                              | 60.0                   | 65.2              | 65.7    | 72.4    | -2                               |
| Toxic substances  | 34.6                                              | 36.9                   | 27.9              | 16.6    | 8.5     | 24                               |
| Drinking water    | 28.5                                              | 27.4                   | 22.7              | 17.6    | 16.6    | 26                               |
| Solid waste       | 23.4                                              | 26.4                   | 18.2              | 8.5     | 7.4     | 20                               |
| Interdisciplinary | 21.4                                              | 22.6                   | 22.7              | 19.7    | 12.6    | -3                               |
| Pesticides        | 9.4                                               | 9.4                    | 13.0              | 12.7    | 12.3    | -28                              |
| Radiation         | 3.2                                               | 3.2                    | 3.1               | 1.6     | 0.6     | 3                                |
| TOTAL             | \$386.3                                           | \$393.3                | \$346.9           | \$307.4 | \$306.6 | 5%                               |

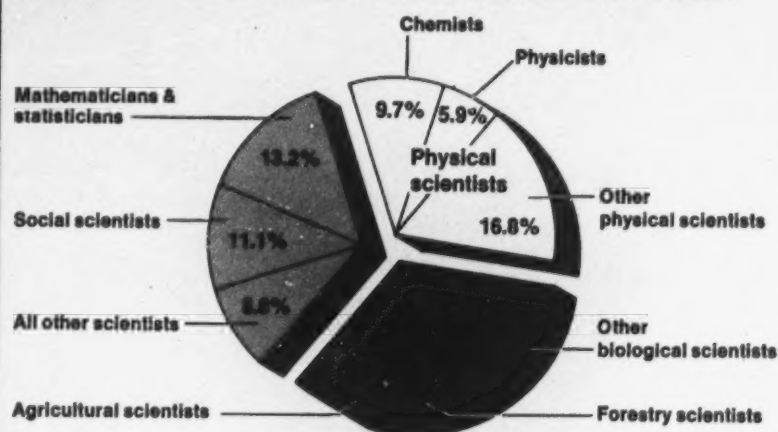
Note: Fiscal years. <sup>a</sup> CEA's estimate based on recent Senate and House action. <sup>b</sup> Estimate. <sup>c</sup> Based on probable Congressional authorization.

## NIH BUDGET: Administration seeks little more than is being spent this year

| Agency                                          | 1981 <sup>a</sup> |                   |          |          |          | % change<br>1980-81 <sup>b</sup> |
|-------------------------------------------------|-------------------|-------------------|----------|----------|----------|----------------------------------|
|                                                 | 1981 <sup>a</sup> | 1980 <sup>b</sup> | 1979     | 1978     | 1977     |                                  |
| National Institutes                             | \$3314.8          | \$3186.9          | \$2994.8 | \$2553.1 | \$2241.1 | 4%                               |
| Cancer                                          | 1006.3            | 1004.2            | 937.1    | 873.2    | 814.2    | 0.4                              |
| Heart, Lung & Blood                             | 548.5             | 528.9             | 510.1    | 447.9    | 396.2    | 4                                |
| Arthritis, Metabolism & Digestive Diseases      | 385.7             | 342.9             | 302.7    | 259.6    | 219.4    | 7                                |
| General Medical Sciences                        | 331.8             | 312.6             | 277.3    | 230.5    | 204.9    | 6                                |
| Neurological & Communicative Disorders & Stroke | 249.9             | 242.6             | 212.1    | 177.4    | 155.3    | 3                                |
| Allergy & Infectious Diseases                   | 228.5             | 216.7             | 191.9    | 164.2    | 104.8    | 6                                |
| Child Health & Human Development                | 217.6             | 200.6             | 197.3    | 149.4    | 146.4    | 4                                |
| Eye                                             | 119.3             | 113.4             | 104.8    | 85.2     | 63.9     | 2                                |
| Environmental Health Sciences                   | 102.3             | 86.3              | 80.6     | 66.6     | 51.0     | 18                               |
| Aging                                           | 75.4              | 70.3              | 66.5     | 37.1     | 29.9     | 7                                |
| Dental Research                                 | 70.5              | 69.0              | 64.4     | 61.8     | 55.5     | 2                                |
| Research resources                              | 190.2             | 174.6             | 168.7    | 146.3    | 137.6    | 9                                |
| National Library of Medicine                    | 46.7              | 46.6              | 41.5     | 36.9     | 35.1     | 0.2                              |
| Office of the director                          | 35.3              | 34.7              | 30.6     | 29.6     | 16.6     | 2                                |
| Research facilities                             | 18.4              | 18.1              | 20.3     | 20.5     | 17.4     | 7                                |
| John E. Fogarty Center                          | 9.3               | 9.7               | 9.4      | 8.5      | 8.0      | 1                                |
| TOTAL                                           | \$3316.2          | \$3182.8          | \$2995.3 | \$2552.6 | \$2240.6 | 4%                               |

Note: Fiscal years. <sup>a</sup> Administration request. <sup>b</sup> Estimate. <sup>c</sup> Based on Administration request.

## Chemists account for almost 10% of all federal scientists



1978 total federal scientists = 84,780<sup>a</sup>

<sup>a</sup> As of October. Source: National Science Foundation

## SCIENTISTS AND ENGINEERS BY AGENCY: Health and defense employ most chemists

| Department or agency                                   | Physical scientists | Chemists    | Physicists  | Engineers     | Chemical engineers | Other scientists | Total scientists and engineers |
|--------------------------------------------------------|---------------------|-------------|-------------|---------------|--------------------|------------------|--------------------------------|
| <b>Defense</b>                                         | <b>8968</b>         | <b>1939</b> | <b>3561</b> | <b>54,449</b> | <b>669</b>         | <b>10,742</b>    | <b>74,159</b>                  |
| Army                                                   | 3252                | 896         | 976         | 19,788        | 386                | 4,259            | 27,299                         |
| Navy                                                   | 3968                | 685         | 2021        | 23,889        | 249                | 2,653            | 30,510                         |
| Air Force                                              | 1204                | 296         | 543         | 9,484         | 28                 | 1,286            | 11,974                         |
| Others                                                 | 544                 | 62          | 21          | 1,288         | 6                  | 2,544            | 4,376                          |
| <b>Veterans Administration</b>                         | <b>731</b>          | <b>660</b>  | <b>52</b>   | <b>932</b>    | <b>0</b>           | <b>2,206</b>     | <b>3,869</b>                   |
| <b>Agriculture</b>                                     | <b>1587</b>         | <b>1055</b> | <b>44</b>   | <b>2,922</b>  | <b>62</b>          | <b>20,460</b>    | <b>24,969</b>                  |
| <b>Health, Education &amp; Welfare</b>                 | <b>2268</b>         | <b>2098</b> | <b>99</b>   | <b>498</b>    | <b>24</b>          | <b>2,822</b>     | <b>7,588</b>                   |
| <b>Interior</b>                                        | <b>4513</b>         | <b>448</b>  | <b>80</b>   | <b>3,074</b>  | <b>83</b>          | <b>6,221</b>     | <b>13,808</b>                  |
| <b>National Aeronautics &amp; Space Administration</b> | <b>1384</b>         | <b>92</b>   | <b>312</b>  | <b>9,154</b>  | <b>10</b>          | <b>885</b>       | <b>11,423</b>                  |
| <b>Commerce</b>                                        | <b>3945</b>         | <b>364</b>  | <b>625</b>  | <b>948</b>    | <b>19</b>          | <b>3,301</b>     | <b>8,194</b>                   |
| <b>Transportation</b>                                  | <b>159</b>          | <b>35</b>   | <b>17</b>   | <b>5,080</b>  | <b>18</b>          | <b>699</b>       | <b>5,938</b>                   |
| <b>Energy</b>                                          | <b>966</b>          | <b>315</b>  | <b>125</b>  | <b>2,634</b>  | <b>225</b>         | <b>529</b>       | <b>4,129</b>                   |
| <b>Environmental Protection Agency</b>                 | <b>1479</b>         | <b>605</b>  | <b>29</b>   | <b>1,868</b>  | <b>176</b>         | <b>905</b>       | <b>4,252</b>                   |
| <b>Tennessee Valley Authority</b>                      | <b>227</b>          | <b>109</b>  | <b>0</b>    | <b>3,214</b>  | <b>150</b>         | <b>556</b>       | <b>3,997</b>                   |
| <b>Others</b>                                          | <b>1258</b>         | <b>536</b>  | <b>25</b>   | <b>4,378</b>  | <b>29</b>          | <b>5,969</b>     | <b>11,605</b>                  |

Note: Data as of October 1978. Source: National Science Foundation

## FEDERAL SCIENTISTS AND ENGINEERS: Total rises after drop in 1973 and 1974

| Thousands                  | 1978         | 1977         | 1976         | 1975         | 1974         | 1973         | 1972         | 1971         | 1970         |
|----------------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| <b>Physical scientists</b> | <b>27.5</b>  | <b>27.1</b>  | <b>27.1</b>  | <b>26.7</b>  | <b>26.3</b>  | <b>26.4</b>  | <b>27.4</b>  | <b>30.4</b>  | <b>29.8</b>  |
| Chemists                   | 8.3          | 8.0          | 8.1          | 8.0          | 7.8          | 8.0          | 8.4          | 8.3          | 8.1          |
| Physicists                 | 5.0          | 5.1          | 5.3          | 5.4          | 5.5          | 5.6          | 5.8          | 5.4          | 5.4          |
| <b>Engineers</b>           | <b>89.2</b>  | <b>87.8</b>  | <b>87.0</b>  | <b>86.6</b>  | <b>82.5</b>  | <b>84.3</b>  | <b>87.0</b>  | <b>84.2</b>  | <b>83.0</b>  |
| Chemical                   | 1.5          | 1.4          | 1.4          | 1.4          | 1.4          | 1.5          | 1.6          | 1.5          | 1.4          |
| <b>Other scientists</b>    | <b>57.2</b>  | <b>54.3</b>  | <b>51.6</b>  | <b>50.6</b>  | <b>48.8</b>  | <b>48.4</b>  | <b>50.1</b>  | <b>48.7</b>  | <b>47.4</b>  |
| <b>TOTAL</b>               | <b>173.9</b> | <b>169.2</b> | <b>165.7</b> | <b>163.9</b> | <b>157.6</b> | <b>159.1</b> | <b>164.5</b> | <b>163.3</b> | <b>160.2</b> |

Note: As of October of each year. Source: National Science Foundation

### Industrial R&D expands at an accelerating clip

*In the chemical industry, spending on R&D last year increased more than at any time since 1974 to show a gain even after factoring out inflation*

#### TOTAL FUNDS FOR INDUSTRIAL R&D: Chemical industry's outlays grow better than average

| \$ Millions                          | 1979 <sup>a</sup> | 1978            | 1977            | 1976            | 1975            | 1974            | 1973            | 1972            | 1971            | 1970            | 1969            | Annual change |           |
|--------------------------------------|-------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|---------------|-----------|
|                                      |                   |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 | 1978-79       | 1969-79   |
| <b>Chemicals and allied products</b> | <b>\$ 4,100</b>   | <b>\$ 3,598</b> | <b>\$ 3,256</b> | <b>\$ 3,017</b> | <b>\$ 2,727</b> | <b>\$ 2,450</b> | <b>\$ 2,116</b> | <b>\$ 1,932</b> | <b>\$ 1,832</b> | <b>\$ 1,773</b> | <b>\$ 1,660</b> | <b>14%</b>    | <b>9%</b> |
| Industrial chemicals                 | 2,085             | 1,835           | 1,685           | 1,524           | 1,391           | 1,299           | 1,119           | 1,031           | 1,009           | 1,031           | 1,007           | 14            | 8         |
| Drugs                                | 1,475             | 1,282           | 1,154           | 1,091           | 981             | 807             | 698             | 607             | 549             | 485             | 444             | 15            | 13        |
| Other chemicals                      | 540               | 481             | 417             | 401             | 354             | 344             | 299             | 294             | 274             | 257             | 209             | 12            | 10        |
| <b>Other industries</b>              | <b>33,550</b>     | <b>29,802</b>   | <b>26,672</b>   | <b>23,980</b>   | <b>21,460</b>   | <b>20,437</b>   | <b>19,133</b>   | <b>17,620</b>   | <b>16,488</b>   | <b>16,294</b>   | <b>16,648</b>   | <b>13</b>     | <b>7</b>  |
| <b>TOTAL</b>                         | <b>\$37,650</b>   | <b>\$33,400</b> | <b>\$29,928</b> | <b>\$26,997</b> | <b>\$24,167</b> | <b>\$22,887</b> | <b>\$21,249</b> | <b>\$19,552</b> | <b>\$18,320</b> | <b>\$18,067</b> | <b>\$18,308</b> | <b>13%</b>    | <b>7%</b> |

<sup>a</sup> C&EN estimates. Source: National Science Foundation

#### FEDERAL FUNDS FOR INDUSTRIAL R&D: Chemical firms get relatively little federal support

| \$ Millions                          | 1979 <sup>a</sup> | 1978            | 1977            | 1976           | 1975           | 1974           | 1973           | 1972           | 1971           | 1970           | 1969           | Annual change |           |
|--------------------------------------|-------------------|-----------------|-----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|---------------|-----------|
|                                      |                   |                 |                 |                |                |                |                |                |                |                |                | 1978-79       | 1969-79   |
| <b>Chemicals and allied products</b> | <b>\$ 400</b>     | <b>\$ 365</b>   | <b>\$ 300</b>   | <b>\$ 266</b>  | <b>\$ 236</b>  | <b>\$ 214</b>  | <b>\$ 203</b>  | <b>\$ 189</b>  | <b>\$ 184</b>  | <b>\$ 180</b>  | <b>\$ 192</b>  | <b>10%</b>    | <b>8%</b> |
| Industrial chemicals                 | 380               | 347             | 284             | 249            | 218            | 194            | 183            | 171            | 159            | 158            | 165            | 10            | 9         |
| Drugs and other chemicals            | 20                | 18              | 16              | 17             | 18             | 20             | 20             | 18             | 25             | 22             | 27             | 11            | -3        |
| <b>Other industries</b>              | <b>12,100</b>     | <b>10,937</b>   | <b>10,221</b>   | <b>9,295</b>   | <b>8,369</b>   | <b>8,006</b>   | <b>7,942</b>   | <b>7,828</b>   | <b>7,482</b>   | <b>7,599</b>   | <b>8,259</b>   | <b>11</b>     | <b>4</b>  |
| <b>TOTAL</b>                         | <b>\$12,500</b>   | <b>\$11,302</b> | <b>\$10,521</b> | <b>\$9,561</b> | <b>\$8,605</b> | <b>\$8,220</b> | <b>\$8,145</b> | <b>\$8,017</b> | <b>\$7,666</b> | <b>\$7,779</b> | <b>\$8,451</b> | <b>11%</b>    | <b>4%</b> |

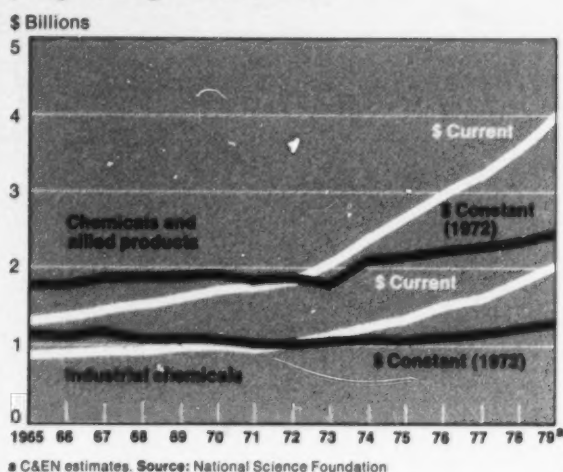
<sup>a</sup> C&EN estimates. Source: National Science Foundation

#### COMPANY FUNDS FOR INDUSTRIAL R&D: Spending continues to rise

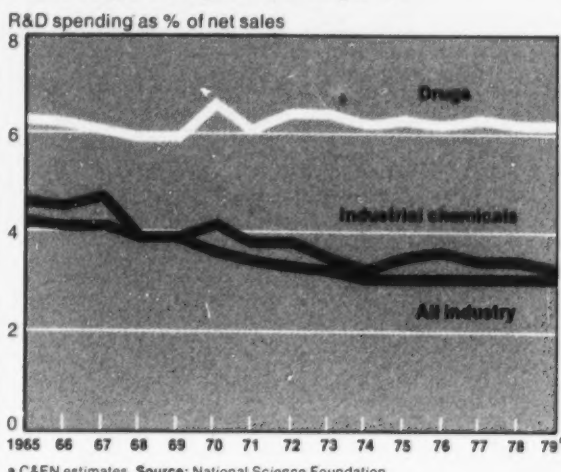
| \$ Millions                          | 1979 <sup>a</sup> | 1978            | 1977            | 1976            | 1975            | 1974            | 1973            | 1972            | 1971            | 1970            | 1969           | Annual change |            |
|--------------------------------------|-------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|----------------|---------------|------------|
|                                      |                   |                 |                 |                 |                 |                 |                 |                 |                 |                 |                | 1978-79       | 1969-79    |
| <b>Chemicals and allied products</b> | <b>\$ 3,700</b>   | <b>\$ 3,232</b> | <b>\$ 2,956</b> | <b>\$ 2,751</b> | <b>\$ 2,490</b> | <b>\$ 2,236</b> | <b>\$ 1,913</b> | <b>\$ 1,741</b> | <b>\$ 1,648</b> | <b>\$ 1,593</b> | <b>\$1,468</b> | <b>14%</b>    | <b>10%</b> |
| Industrial chemicals                 | 1,705             | 1,488           | 1,402           | 1,275           | 1,173           | 1,105           | 936             | 860             | 850             | 873             | 842            | 15            | 7          |
| Drugs and other chemicals            | 1,995             | 1,744           | 1,554           | 1,476           | 1,317           | 1,131           | 977             | 881             | 798             | 720             | 616            | 14            | 12         |
| <b>Other industries</b>              | <b>21,450</b>     | <b>18,866</b>   | <b>16,451</b>   | <b>14,685</b>   | <b>13,092</b>   | <b>12,431</b>   | <b>11,191</b>   | <b>9,794</b>    | <b>9,006</b>    | <b>8,695</b>    | <b>8,389</b>   | <b>14</b>     | <b>10</b>  |
| <b>TOTAL</b>                         | <b>\$25,150</b>   | <b>\$22,098</b> | <b>\$19,407</b> | <b>\$17,436</b> | <b>\$15,582</b> | <b>\$14,667</b> | <b>\$13,104</b> | <b>\$11,535</b> | <b>\$10,654</b> | <b>\$10,288</b> | <b>\$9,857</b> | <b>14%</b>    | <b>10%</b> |

<sup>a</sup> C&EN estimates. Source: National Science Foundation

## Chemical Industry's R&D makes small progress against inflation



## R&D's share of industry's sales holds relatively steady in recent years



## COMPANY R&D SPENDING: Major chemical firms plan some large increases in 1980

| \$ Millions                      | 1980 <sup>a</sup> | 1979          | 1978          | 1977          | 1976          | 1975          | 1974         | 1973         | 1972         | 1971         | 1970         |
|----------------------------------|-------------------|---------------|---------------|---------------|---------------|---------------|--------------|--------------|--------------|--------------|--------------|
| Air Products                     | \$ 27             | \$ 23         | \$ 23         | \$ 24         | \$ 19         | \$ 16         | \$ 11        | \$ 8         | \$ 7         | \$ 7         | \$ 5         |
| Akzona                           | 29                | 25            | 23            | 20            | 18            | 17            | 16           | 13           | 11           | 10           | 7            |
| Allied Chemical                  | 75                | 70            | 56            | 51            | 40            | 35            | 31           | 29           | 29           | 31           | 29           |
| American Cyanamid                | 140               | 124           | 108           | 96            | 83            | 73            | 64           | 52           | 44           | 43           | 47           |
| Celanese                         | 100               | 92            | 83            | 77            | 70            | 64            | 58           | 49           | 52           | 51           | 55           |
| Diamond Shamrock                 | 50                | 42            | 36            | 29            | 24            | 20            | 14           | 12           | 12           | 11           | 11           |
| Dow Chemical                     | 310 <sup>b</sup>  | 269           | 232           | 203           | 188           | 167           | 149          | 118          | 105          | 95           | 92           |
| Du Pont                          | 480               | 415           | 377           | 367           | 353           | 336           | 344          | 286          | 265          | 259          | 270          |
| Ethyl Corp. <sup>c</sup>         | na                | 29            | 25            | 28            | 25            | 19            | 25           | 22           | 20           | 20           | 18           |
| W. R. Grace                      | 50                | 46            | 41            | 34            | 30            | 30            | 32           | 28           | 22           | 21           | 21           |
| Hercules                         | 53                | 47            | 40            | 37            | 35            | 30            | 30           | 25           | 24           | 22           | 22           |
| Monsanto <sup>d</sup>            | 195               | 174           | 144           | 132           | 114           | 116           | 87           | 82           | 92           | 87           | 98           |
| Olin <sup>e</sup>                | na                | 26            | 25            | 25            | 25            | 24            | 19           | 18           | 16           | 8            | 8            |
| Pennwalt <sup>d</sup>            | na                | 24            | 23            | 21            | 19            | 16            | 14           | 13           | 18           | 17           | 18           |
| Rohm & Haas                      | 62                | 54            | 49            | 45            | 43            | 45            | 39           | 32           | 25           | 29           | 31           |
| Stauffer Chemical                | 45                | 37            | 34            | 33            | 29            | 24            | 20           | 17           | 14           | 14           | 14           |
| Union Carbide                    | 174               | 161           | 156           | 156           | 142           | 120           | 94           | 77           | 70           | 78           | 78           |
| <b>TOTAL<sup>f</sup></b>         | <b>\$1790</b>     | <b>\$1579</b> | <b>\$1402</b> | <b>\$1304</b> | <b>\$1188</b> | <b>\$1093</b> | <b>\$989</b> | <b>\$828</b> | <b>\$772</b> | <b>\$758</b> | <b>\$780</b> |
| <b>ANNUAL CHANGE<sup>f</sup></b> | <b>13%</b>        | <b>13%</b>    | <b>8%</b>     | <b>10%</b>    | <b>9%</b>     | <b>11%</b>    | <b>19%</b>   | <b>7%</b>    | <b>2%</b>    | <b>-3%</b>   | <b>1%</b>    |

<sup>a</sup> Planned. <sup>b</sup> C&EN estimate. <sup>c</sup> R&D definition narrowed after 1974. <sup>d</sup> R&D definition narrowed after 1972. <sup>e</sup> For chemicals only before 1972. <sup>f</sup> For 14 companies only. na = not available. Sources: Company data, C&EN estimates

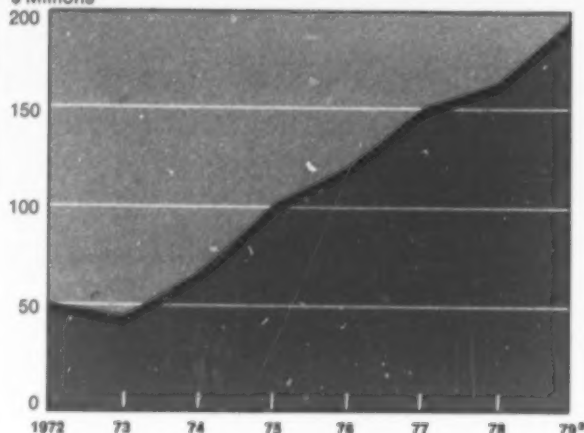
## R&D BY U.S. COMPANIES ABROAD: Outlays overseas grow relatively fast for drug firms

| \$ Millions                    | 1979 <sup>a</sup> | 1978          | 1977          | 1976          | 1975          | 1974          | Annual change |            |
|--------------------------------|-------------------|---------------|---------------|---------------|---------------|---------------|---------------|------------|
|                                |                   |               |               |               |               |               | 1978-79       | 1974-79    |
| Chemicals and allied products  | \$ 460            | \$ 396        | \$ 332        | \$ 312        | \$ 269        | \$ 208        | 16%           | 17%        |
| Industrial and other chemicals | 170               | 152           | 133           | 108           | 85            | 82            | 12            | 16         |
| Drugs                          | 290               | 243           | 199           | 204           | 184           | 126           | 19            | 18         |
| Other industries               | 1990              | 1770          | 1526          | 1332          | 1172          | 1082          | 12            | 13         |
| <b>TOTAL</b>                   | <b>\$2450</b>     | <b>\$2166</b> | <b>\$1858</b> | <b>\$1644</b> | <b>\$1441</b> | <b>\$1290</b> | <b>13%</b>    | <b>14%</b> |

<sup>a</sup> C&EN estimates. Source: National Science Foundation

## Chemical industry's spending on energy R&D has nearly doubled since 1975...

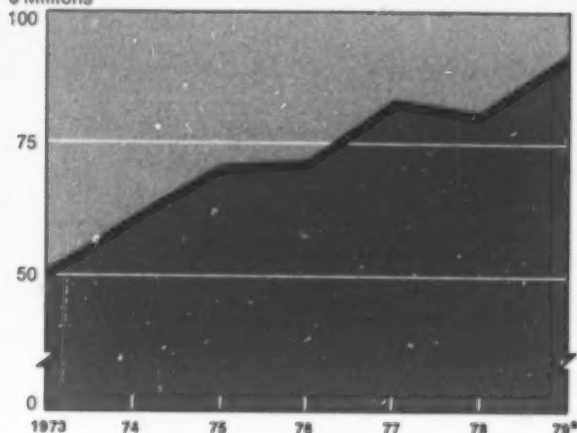
\$ Millions



■ C&EN estimates. Source: National Science Foundation

## ... but outlays for R&D on pollution abatement have increased more slowly

\$ Millions



## DRUG R&D: Products for human use account for bulk of spending

R&D expenditures for ethical pharmaceuticals, \$ millions

|                                              | 1979 <sup>b</sup> | 1978            | 1977            | 1976            | 1975            | 1974           | 1973           | 1972           | 1971           | 1970           | 1969           | Annual change |            |
|----------------------------------------------|-------------------|-----------------|-----------------|-----------------|-----------------|----------------|----------------|----------------|----------------|----------------|----------------|---------------|------------|
| Company spending on human-use drugs          | \$1495.1          | \$1311.2        | \$1181.8        | \$1067.8        | \$973.5         | \$858.5        | \$752.5        | \$666.8        | \$628.8        | \$565.8        | \$505.8        | 14%           | 11%        |
| In U.S.                                      | 1225.2            | 1089.2          | 984.1           | 902.2           | 828.6           | 726.0          | 643.8          | 600.7          | 576.5          | 518.6          | 464.1          | 12            | 10         |
| In foreign countries                         | 269.9             | 222.0           | 197.7           | 164.9           | 144.9           | 132.5          | 108.7          | 66.1           | 52.3           | 46.9           | 41.7           | 22            | 20         |
| Company spending on veterinary-use drugs     | 97.7              | 85.8            | 84.3            | 86.8            | 79.0            | 73.7           | 61.9           | 52.5           | 47.9           | 45.1           | 33.8           | 14            | 11         |
| In U.S.                                      | 78.1              | 69.9            | 68.9            | 71.4            | 65.9            | 58.5           | 53.7           | 47.3           | 43.1           | 40.0           | 30.5           | 12            | 10         |
| In foreign countries                         | 19.6              | 15.9            | 15.4            | 15.4            | 13.1            | 15.2           | 8.2            | 5.2            | 4.8            | 5.1            | 3.3            | 23            | 20         |
| Government grants and contracts              | 6.8               | 7.0             | 10.0            | 9.1             | 9.0             | 8.6            | 10.6           | 6.8            | 7.1            | 7.8            | 9.8            | -3            | -4         |
| <b>TOTAL PHARMACEUTICAL R&amp;D SPENDING</b> | <b>\$1599.6</b>   | <b>\$1404.0</b> | <b>\$1276.1</b> | <b>\$1163.7</b> | <b>\$1061.5</b> | <b>\$940.8</b> | <b>\$881.3</b> | <b>\$726.1</b> | <b>\$683.8</b> | <b>\$618.5</b> | <b>\$549.2</b> | <b>14%</b>    | <b>11%</b> |

a In the U.S. and abroad for U.S. drug companies and in the U.S. only for U.S.-based subsidiaries of foreign companies. b Budgeted. Source: Pharmaceutical Manufacturers Association

## FUNCTION OF DRUG R&D: Clinical studies, screening, and testing are major activities

| R&D function                                     | % of total drug R&D spending <sup>a</sup> |       |       |       |
|--------------------------------------------------|-------------------------------------------|-------|-------|-------|
|                                                  | 1978                                      | 1977  | 1976  | 1975  |
| Clinical evaluation                              | 21.3%                                     | 22.5% | 23.4% | 22.5% |
| Biological screening and pharmacological testing | 18.8                                      | 18.7  | 19.5  | 20.0  |
| Synthesis and extraction                         | 16.3                                      | 17.2  | 16.6  | 15.0  |
| Dosage formulation and stability testing         | 10.1                                      | 9.7   | 9.1   | 8.4   |
| Toxicology and safety testing                    | 10.0                                      | 9.2   | 8.9   | 9.0   |
| Process development and quality control          | 9.2                                       | 8.8   | 9.5   | 9.8   |
| Regulatory preparation and submission            | 3.6                                       | 3.3   | 3.3   | 3.2   |
| Bioavailability studies                          | 2.2                                       | 2.3   | 2.2   | 2.2   |
| Other                                            | 8.5                                       | 8.3   | 7.5   | 9.9   |

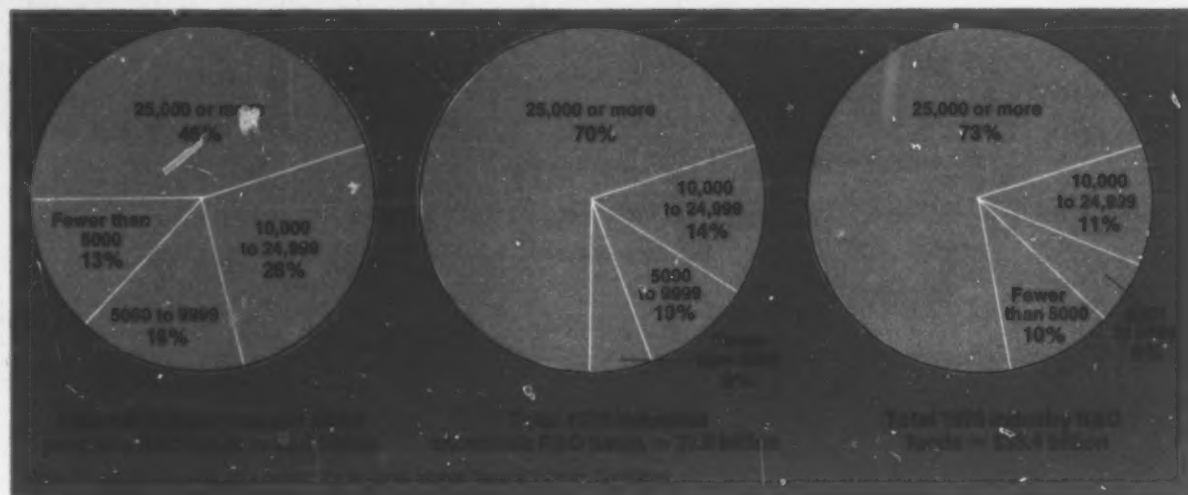
a In U.S. only. Source: Pharmaceutical Manufacturers Association

## ALLOCATION OF DRUG R&D: Largest share goes to fight infection

| Product class                                      | % of total R&D spending <sup>a</sup> |       |       |       |
|----------------------------------------------------|--------------------------------------|-------|-------|-------|
|                                                    | 1978                                 | 1977  | 1976  | 1975  |
| Anti-infectives                                    | 18.9%                                | 19.2% | 19.5% | 20.1% |
| Central nervous system and sense organs            | 16.8                                 | 17.0  | 16.2  | 18.0  |
| Cardiovasculars                                    | 16.6                                 | 15.2  | 13.2  | 14.9  |
| Neoplasms, endocrine system and metabolic diseases | 16.4                                 | 15.7  | 14.7  | 15.5  |
| Gastrointestinal and genitourinary system          | 6.2                                  | 6.0   | 5.8   | 5.1   |
| Respiratory                                        | 4.0                                  | 4.0   | 4.1   | 5.5   |
| Biologicals                                        | 3.2                                  | 3.1   | 3.1   | 3.0   |
| Dermatologicals                                    | 3.1                                  | 3.2   | 2.8   | 2.8   |
| Vitamins                                           | 2.4                                  | 2.5   | 1.5   | 1.1   |
| Diagnostic (in vivo)                               | 0.5                                  | 0.8   | 1.2   | 1.2   |
| Other human preparations                           | 5.6                                  | 6.3   | 10.5  | 6.1   |
| Veterinary preparations                            | 5.9                                  | 6.6   | 7.2   | 6.5   |
| Veterinary biologicals                             | 0.4                                  | 0.4   | 0.2   | 0.2   |

a In U.S. only. Source: Pharmaceutical Manufacturers Association

## Largest firms account for greatest percentage of R&D spending

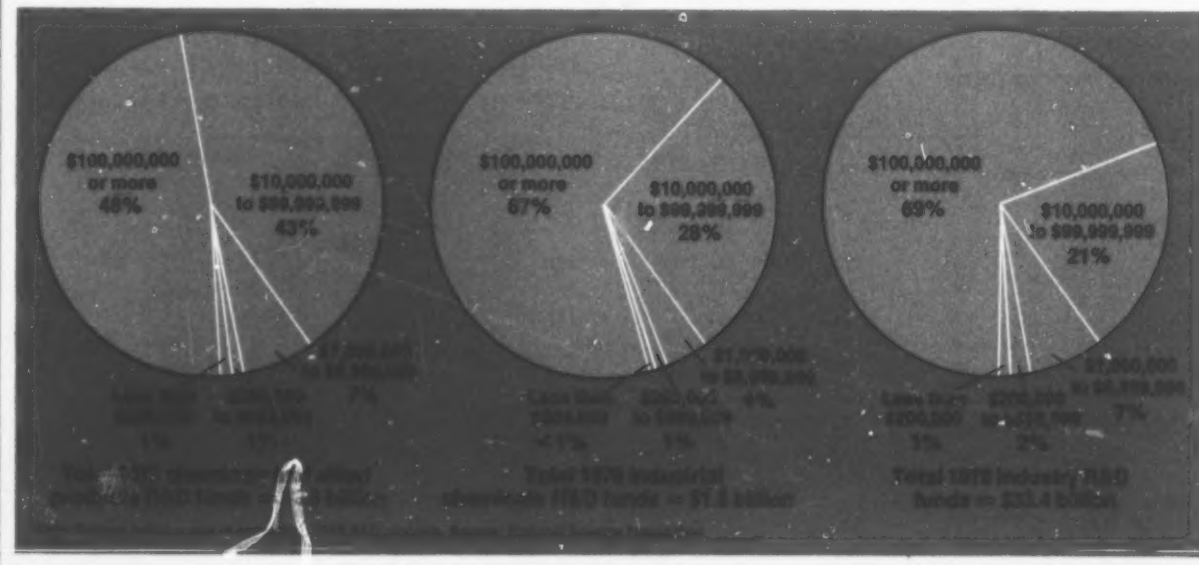


## R&D SCIENTISTS AND ENGINEERS IN INDUSTRY: Drug industry employees up considerably

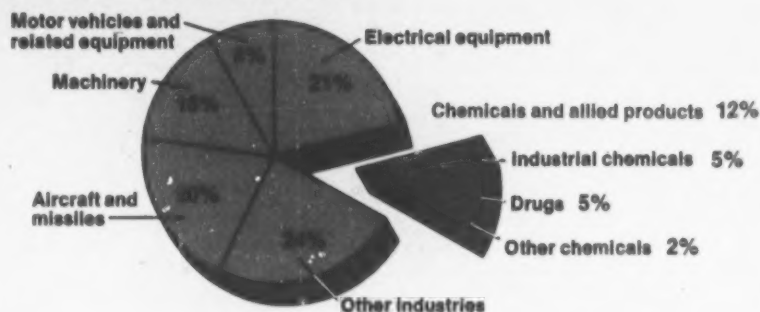
| Thousands*                           | 1979         | 1978         | 1977         | 1976         | 1975         | 1974         | 1973         | 1972         | 1971         | 1970         | 1969         |
|--------------------------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| <b>Chemicals and allied products</b> | <b>49.4</b>  | <b>47.9</b>  | <b>46.4</b>  | <b>44.4</b>  | <b>45.2</b>  | <b>41.8</b>  | <b>40.9</b>  | <b>41.0</b>  | <b>42.7</b>  | <b>40.1</b>  | <b>38.9</b>  |
| Industrial chemicals                 | 21.8         | 21.5         | 20.6         | 20.1         | 21.1         | 19.1         | 19.1         | 19.1         | 21.8         | 21.5         | 22.3         |
| Drugs                                | 19.9         | 18.9         | 17.8         | 16.6         | 15.6         | 14.0         | 13.0         | 13.1         | 12.3         | 11.8         | 9.8          |
| Other chemicals                      | 7.6          | 7.4          | 8.0          | 7.8          | 8.5          | 8.7          | 8.8          | 8.8          | 8.6          | 6.8          | 6.8          |
| <b>Other industries</b>              | <b>378.4</b> | <b>355.8</b> | <b>336.4</b> | <b>320.0</b> | <b>318.1</b> | <b>318.2</b> | <b>316.8</b> | <b>309.2</b> | <b>324.3</b> | <b>344.1</b> | <b>337.8</b> |
| <b>TOTAL</b>                         | <b>427.8</b> | <b>403.7</b> | <b>382.8</b> | <b>364.4</b> | <b>363.3</b> | <b>360.0</b> | <b>357.7</b> | <b>350.2</b> | <b>367.0</b> | <b>384.2</b> | <b>376.7</b> |

\* Full-time equivalent. Source: National Science Foundation

## Largest share of R&D done by firms spending more than \$10 million on their programs



## Electrical equipment makers are biggest employer of R&D scientists and engineers<sup>a</sup>



<sup>a</sup> Full time equivalent. Source: National Science Foundation

## R&D SCIENTISTS AND ENGINEERS PER 1000 EMPLOYEES: Ratio high in chemical industry

|                               | 1978 | 1977 | 1976 | 1975 | 1974 | 1973 | 1972 | 1971 | 1970 | 1969 | 1968 |
|-------------------------------|------|------|------|------|------|------|------|------|------|------|------|
| Chemicals and allied products | 42   | 42   | 40   | 41   | 40   | 39   | 39   | 41   | 39   | 35   | 35   |
| Industrial chemicals          | 39   | 38   | 36   | 38   | 37   | 36   | 34   | 35   | 35   | 32   | 32   |
| Drugs                         | 63   | 62   | 64   | 59   | 57   | 57   | 60   | 65   | 65   | 48   | 48   |
| Other chemicals               | 25   | 28   | 28   | 29   | 30   | 29   | 31   | 31   | 30   | 31   | 30   |
| TOTAL INDUSTRY                | 28   | 27   | 27   | 26   | 25   | 24   | 24   | 26   | 26   | 26   | 26   |

Source: National Science Foundation

## COST PER INDUSTRIAL R&D SCIENTIST OR ENGINEER: Past decade has shown a steady rise

| \$ Thousands                  | 1978   | 1977   | 1976   | 1975   | 1974   | 1973   | 1972   | 1971   | 1970   | 1969   | 1967 <sup>a</sup> |
|-------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------------------|
| Chemicals and allied products | \$74.0 | \$69.1 | \$66.5 | \$60.9 | \$56.3 | \$51.1 | \$47.1 | \$43.7 | \$42.8 | \$41.4 | \$39.8            |
| Industrial chemicals          | 84.7   | 80.0   | 74.7   | 67.5   | 63.5   | 58.6   | 54.0   | 49.2   | 47.5   | 46.0   | 43.9              |
| Drugs                         | 66.0   | 65.0   | 63.4   | 60.9   | 54.3   | 51.5   | 46.5   | 43.2   | 40.1   | 40.4   | 37.1              |
| Other chemicals               | 64.0   | 54.2   | 50.8   | 43.2   | 45.3   | 34.0   | 33.4   | 35.5   | 33.4   | 29.1   | 29.8              |
| TOTAL INDUSTRY                | \$79.5 | \$76.1 | \$72.2 | \$66.5 | \$63.3 | \$59.2 | \$55.3 | \$51.1 | \$48.1 | \$47.5 | \$44.1            |

<sup>a</sup> Data for 1966 are not available. Source: National Science Foundation

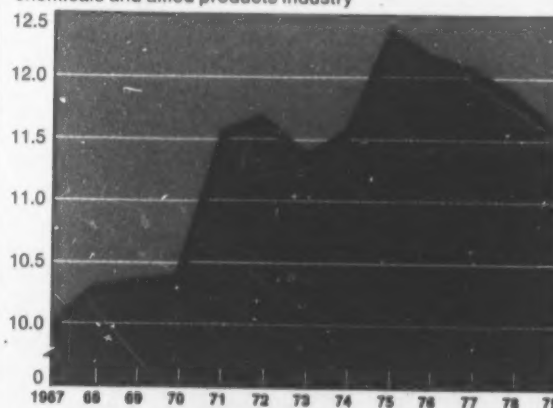
## CHEMISTS IN INDUSTRY: Half work for chemical or drug firms

| Industry            | % of industrial chemists |      |      |       |
|---------------------|--------------------------|------|------|-------|
|                     | All chemists             | B.S. | M.S. | Ph.D. |
| Chemical            | 34%                      | 29%  | 32%  | 39%   |
| Pharmaceutical      | 17                       | 14   | 20   | 17    |
| Coatings            | 6                        | 8    | 5    | 4     |
| Petroleum           | 5                        | 5    | 4    | 6     |
| Food                | 5                        | 6    | 6    | 4     |
| Metals              | 3                        | 5    | 3    | 2     |
| Rubber              | 3                        | 4    | 3    | 2     |
| Paper               | 2                        | 2    | 1    | 2     |
| Other manufacturing | 19                       | 21   | 19   | 18    |
| Nonmanufacturing    | 6                        | 6    | 7    | 6     |

Source: 1980 ACS survey

## Share of scientists, engineers in chemical industry has declined slightly since 1975

% of industrial R&D scientists and engineers<sup>a</sup> in the chemicals and allied products industry



<sup>a</sup> Full-time equivalent. Source: National Science Foundation

## Federal funds continue to bankroll academic R&D

*About two thirds of all R&D done in universities and colleges—and nearly 80 % of the R&D in chemistry—is supported by government agencies*

### SOURCE OF UNIVERSITY R&D FUNDS: Federal government provides two thirds

| \$ Millions                 | 1979 <sup>a</sup> | 1978 <sup>a</sup> | 1977          | 1976          | 1975          | 1974          | 1973          | 1972          | 1971          | 1970          | 1969          | Annual change |           |
|-----------------------------|-------------------|-------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|-----------|
|                             |                   |                   |               |               |               |               |               |               |               |               |               | 1978-79       | 1969-79   |
| Federal government          | \$3600            | \$3057            | \$2729        | \$2512        | \$2288        | \$2033        | \$2038        | \$1839        | \$1724        | \$1648        | \$1600        | 18%           | 8%        |
| State and local governments | 450               | 414               | 374           | 364           | 332           | 307           | 295           | 270           | 255           | 219           | 197           | 9             | 9         |
| Industry                    | 190               | 170               | 139           | 123           | 113           | 96            | 85            | 75            | 70            | 61            | 60            | 12            | 12        |
| Institutional funds         | 700               | 615               | 508           | 444           | 417           | 369           | 319           | 306           | 274           | 243           | 223           | 14            | 12        |
| Other outside sources       | 400               | 359               | 314           | 284           | 258           | 218           | 201           | 187           | 177           | 165           | 145           | 11            | 11        |
| <b>TOTAL</b>                | <b>\$5340</b>     | <b>\$4615</b>     | <b>\$4064</b> | <b>\$3728</b> | <b>\$3408</b> | <b>\$3023</b> | <b>\$2940</b> | <b>\$2677</b> | <b>\$2500</b> | <b>\$2335</b> | <b>\$2225</b> | <b>16%</b>    | <b>9%</b> |

Note: Data for fiscal years. a Estimates. Source: National Science Foundation

### CHARACTER OF UNIVERSITY R&D SPENDING: Basic research dominates academic work

| \$ Millions      | 1979 <sup>a</sup> | 1978          | 1977          | 1976          | 1975          | 1974          | 1973          | 1972          | 1971          | 1970          | 1969          | Annual change |           |
|------------------|-------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|-----------|
|                  |                   |               |               |               |               |               |               |               |               |               |               | 1978-79       | 1969-79   |
| Basic research   | \$3745            | \$3185        | \$2787        | \$2547        | \$2410        | \$2153        | \$2055        | \$2022        | \$1914        | \$1796        | \$1711        | 18%           | 8%        |
| Applied research | 1330              | 1195          | 1068          | 1015          | 851           | 737           | 717           | 544           | 474           | 427           | 407           | 11            | 13        |
| Development      | 265               | 235           | 209           | 168           | 148           | 133           | 168           | 110           | 112           | 112           | 107           | 13            | 9         |
| <b>TOTAL</b>     | <b>\$5340</b>     | <b>\$4615</b> | <b>\$4064</b> | <b>\$3730</b> | <b>\$3409</b> | <b>\$3023</b> | <b>\$2940</b> | <b>\$2676</b> | <b>\$2500</b> | <b>\$2335</b> | <b>\$2225</b> | <b>16%</b>    | <b>9%</b> |

Note: Data for fiscal years. a Preliminary. Source: National Science Foundation

### FIELDS OF UNIVERSITY R&D SPENDING: Chemistry's share is 4% of total

| \$ Millions                   | 1979 <sup>a</sup> | 1978 <sup>b</sup> | 1977          | 1976          | 1975          | 1974          | 1973          | 1972          | 1970 <sup>c</sup> | 1969          | Annual change |          |
|-------------------------------|-------------------|-------------------|---------------|---------------|---------------|---------------|---------------|---------------|-------------------|---------------|---------------|----------|
|                               |                   |                   |               |               |               |               |               |               |                   |               | 1978-79       | 1969-79  |
| Physical sciences             | \$ 560            | \$496.9           | \$428.8       | \$379.8       | \$350.4       | \$333.6       | \$330.4       | \$329.9       | \$307.3           | \$319.7       | 13%           | 5%       |
| Chemistry                     | 210               | 182.5             | 163.6         | 140.3         | 120.8         | 115.9         | 114.1         | 110.9         | 102.0             | 104.7         | 15            | 7        |
| Engineering                   | 690               | 601.1             | 497.3         | 433.2         | 382.2         | 348.0         | 383.6         | 347.3         | 318.8             | 309.1         | 15            | 8        |
| <b>Total R&amp;D spending</b> | <b>5340</b>       | <b>4614.9</b>     | <b>4064.3</b> | <b>3727.6</b> | <b>3408.4</b> | <b>3022.8</b> | <b>2939.6</b> | <b>2676.5</b> | <b>2334.9</b>     | <b>2148.7</b> | <b>16</b>     | <b>9</b> |

Note: Data for fiscal years. a CAEN estimates. b NSF estimates. c Data for 1969 and 1971 not available. Source: National Science Foundation

### FEDERALLY FINANCED R&D SPENDING AT UNIVERSITIES: Better-than-average gains lately

| \$ Millions                   | 1979 <sup>a</sup> | 1978 <sup>b</sup> | 1977          | 1976          | 1975          | 1974          | 1973          | 1972          | 1970 <sup>c</sup> | 1969          | Annual change |          |
|-------------------------------|-------------------|-------------------|---------------|---------------|---------------|---------------|---------------|---------------|-------------------|---------------|---------------|----------|
|                               |                   |                   |               |               |               |               |               |               |                   |               | 1978-79       | 1969-79  |
| Physical sciences             | \$ 465            | \$393.4           | \$343.3       | \$305.4       | \$285.0       | \$270.2       | \$270.4       | \$267.4       | \$257.8           | \$273.0       | 18%           | 5%       |
| Chemistry                     | 165               | 138.2             | 125.2         | 107.9         | 92.7          | 88.7          | 86.9          | 84.6          | 78.9              | 82.7          | 19            | 6        |
| Engineering                   | 470               | 407.6             | 336.2         | 291.4         | 260.2         | 240.1         | 287.1         | 259.1         | 245.9             | 246.2         | 15            | 6        |
| <b>Total R&amp;D spending</b> | <b>3600</b>       | <b>3056.9</b>     | <b>2729.0</b> | <b>2511.9</b> | <b>2287.9</b> | <b>2032.6</b> | <b>2038.2</b> | <b>1838.9</b> | <b>1647.5</b>     | <b>1572.1</b> | <b>18</b>     | <b>8</b> |

Note: Data for fiscal years. a CAEN estimates. b NSF estimates. c Data for 1969 and 1971 not available. Source: National Science Foundation

## TOP 12 PH.D.-GRANTING SCHOOLS IN R&D SPENDING: MIT, Wisconsin head the list

| \$ Millions, fiscal 1978          | Physical sciences | Chemistry <sup>a</sup> | Engineering       | Environmental sciences | Life sciences     | Math and computer sciences | Total <sup>b</sup> |
|-----------------------------------|-------------------|------------------------|-------------------|------------------------|-------------------|----------------------------|--------------------|
| Massachusetts Inst. of Technology | \$37.3            | \$6.2                  | \$43.2            | \$ 7.1                 | \$16.6            | \$7.7                      | \$119.6            |
| U of Wisconsin, Madison           | 11.5              | 5.1                    | 8.4               | 11.1                   | 56.9              | 3.6                        | 107.9              |
| U of California, San Diego        | 9.5               | 3.6                    | 1.9               | 52.6                   | 29.4              | 0.4                        | 95.2               |
| U of Minnesota                    | 5.0               | 1.8                    | 7.6               | 1.8                    | 71.1              | 1.2                        | 94.7               |
| U of Washington                   | 4.1               | 0.9                    | 4.9               | 11.3                   | 56.4              | 1.2                        | 89.0               |
| Stanford U                        | 15.6 <sup>c</sup> | 3.5 <sup>c</sup>       | 21.8 <sup>c</sup> | 2.6 <sup>c</sup>       | 37.7 <sup>c</sup> | 6.7 <sup>c</sup>           | 88.2 <sup>c</sup>  |
| U of Michigan                     | 4.0               | 1.2                    | 14.5              | 8.6                    | 38.8              | 1.6                        | 86.9               |
| Harvard U                         | 11.3 <sup>c</sup> | 3.9 <sup>c</sup>       | 1.5 <sup>c</sup>  | 4.7 <sup>c</sup>       | 52.6 <sup>c</sup> | 1.1 <sup>c</sup>           | 84.2 <sup>c</sup>  |
| Cornell U                         | 14.6              | 3.4                    | 11.0              | 1.5                    | 48.7              | 0.8                        | 83.4               |
| U of Pennsylvania                 | 5.9               | 1.8                    | 4.1               | 0.4                    | 49.5              | 2.5                        | 76.5               |
| Columbia U, main division         | 10.1              | 3.3                    | 5.8               | 12.5                   | 41.0              | 0.5                        | 74.6               |
| U of Illinois, Urbana             | 8.0               | 3.2                    | 17.2              | 6.9                    | 20.5              | 8.8                        | 73.9               |

<sup>a</sup> Included in physical sciences. <sup>b</sup> Includes social sciences and other sciences not listed separately. <sup>c</sup> Estimated. Source: National Science Foundation

## TOP 12 UNIVERSITY R&D CENTERS:<sup>a</sup> Physical sciences get big share of R&D funds

| \$ Millions, fiscal 1978                 | Physical sciences | Engineering | Environmental sciences | Life sciences | Total   |
|------------------------------------------|-------------------|-------------|------------------------|---------------|---------|
| Lawrence Livermore Lab                   | \$244.1           | \$27.6      | \$21.9                 | \$ 4.3        | \$303.5 |
| Los Alamos Scientific Lab                | 90.9              | 164.5       | 9.2                    | 5.7           | 287.9   |
| Jet Propulsion Lab                       | 50.7              | 128.0       | 8.6                    | 4.2           | 278.5   |
| Argonne National Lab                     | 76.4              | 93.5        | 38.8                   | 13.3          | 231.1   |
| Brookhaven National Lab                  | 64.9              | 19.6        | 7.5                    | 13.8          | 112.2   |
| Lincoln Lab                              | 20.0              | 73.3        | 0                      | 0             | 103.8   |
| Lawrence Berkeley Lab                    | 57.1              | 11.8        | 12.4                   | 14.4          | 99.5    |
| Plasma Physics Lab                       | 76.2              | 0           | 0                      | 0             | 76.2    |
| Stanford Linear Accelerator Center       | 74.6              | 0           | 0                      | 0             | 74.6    |
| Fermi National Accelerator Lab           | 60.2              | 0           | 0                      | 0             | 60.2    |
| National Center for Atmospheric Research | 4.9               | 0           | 28.7                   | 0             | 33.6    |
| Ames Lab                                 | 8.4               | 3.8         | 0                      | 0             | 12.2    |

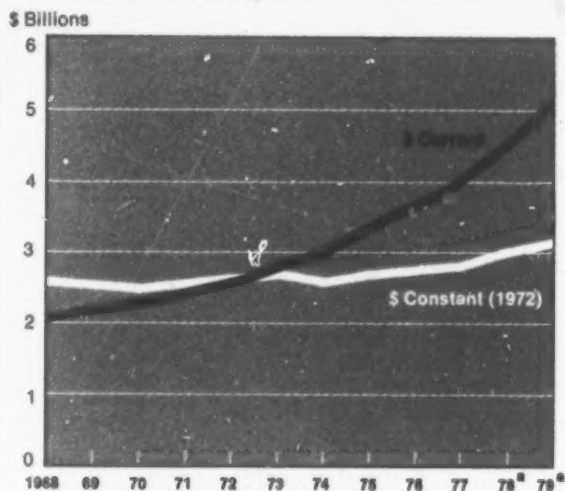
<sup>a</sup> Data for university-administered federally funded research and development centers. Source: National Science Foundation

## UNIVERSITY SCIENTISTS AND ENGINEERS: 4% are chemists

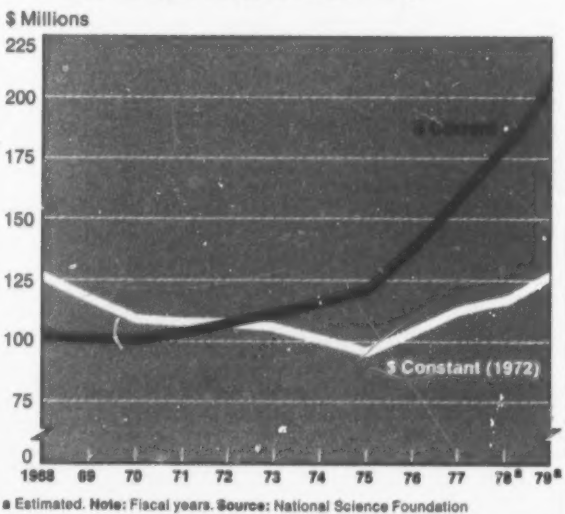
| Thousands of scientists and engineers <sup>a</sup> | 1979  | 1978  | 1977  | 1976  | 1975  | 1974  | 1973  |
|----------------------------------------------------|-------|-------|-------|-------|-------|-------|-------|
| <b>TOTAL</b>                                       |       |       |       |       |       |       |       |
| Physical scientists                                | 18.4  | 18.2  | 17.7  | 17.3  | 16.6  | 17.0  | 16.8  |
| Chemists                                           | 9.1   | 9.1   | 8.7   | 8.5   | 8.1   | 8.4   | 7.9   |
| Physicists                                         | 7.6   | 7.7   | 7.4   | 7.2   | 7.1   | 7.1   | 7.1   |
| Engineers                                          | 22.7  | 21.7  | 21.2  | 20.0  | 19.5  | 19.6  | 19.4  |
| Chemical                                           | 1.9   | 1.8   | 1.7   | 1.6   | 1.6   | 1.5   | 1.5   |
| Other scientists                                   | 186.5 | 180.0 | 153.9 | 148.6 | 143.9 | 138.3 | 138.3 |
| <b>TOTAL</b>                                       | 207.6 | 199.9 | 192.8 | 185.9 | 180.0 | 175.1 | 174.5 |
| <b>FULL-TIME ONLY</b>                              |       |       |       |       |       |       |       |
| Physical scientists                                | 16.0  | 16.2  | 15.9  | 15.5  | 14.8  | 15.2  | 15.0  |
| Chemists                                           | 7.8   | 7.9   | 7.7   | 7.4   | 7.0   | 7.5   | 6.9   |
| Physicists                                         | 6.9   | 7.0   | 6.8   | 6.6   | 6.5   | 6.5   | 6.6   |
| Engineers                                          | 19.1  | 18.4  | 18.0  | 17.0  | 16.6  | 17.0  | 17.1  |
| Chemical                                           | 1.6   | 1.5   | 1.5   | 1.4   | 1.4   | 1.3   | 1.3   |
| Other scientists                                   | 135.6 | 129.8 | 125.7 | 121.2 | 116.5 | 112.3 | 111.3 |
| <b>TOTAL</b>                                       | 170.7 | 164.4 | 159.6 | 153.7 | 147.9 | 144.5 | 143.4 |

Note: Data for Ph.D.-granting institutions only. <sup>a</sup> In January of each year. Source: National Science Foundation

## Since mid-1970's, spending for academic R&D has been rising in constant dollars ...

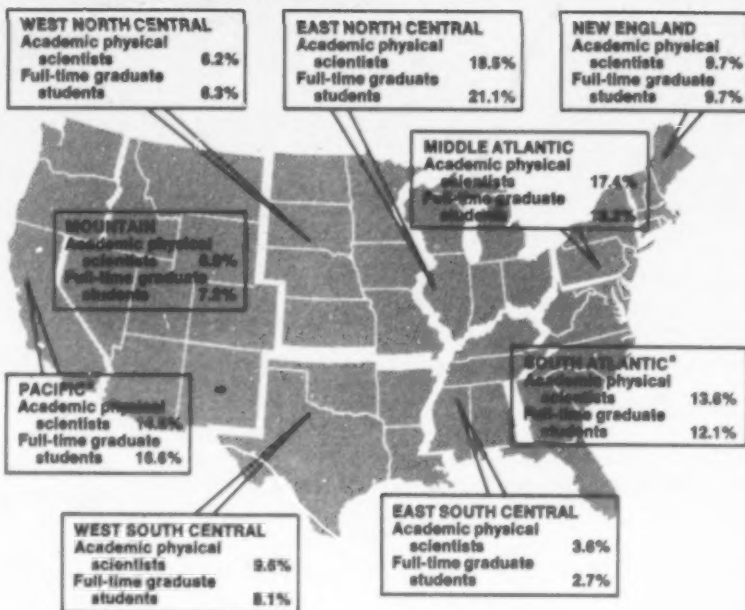


## ... as has the amount of real spending devoted to research in chemistry



<sup>a</sup> Estimated. Note: Fiscal years. Source: National Science Foundation

### East North Central schools lead in graduate students and employees in the physical sciences



Key to map: Using Middle Atlantic as an example, 17.4% of all academic physical scientists work in this geographical area and 18.3% of all full-time graduate students go to school in this area. a Includes Puerto Rico. b Includes Alaska and Hawaii. Note: Academic physical scientists data as of January 1979 when a total of 18,400 were employed; full-time graduate student data as of 1978 when 21,700 were majoring in the physical sciences. Source: National Science Foundation

### CHEMICAL DEGREES: Ph.D.'s are declining as others increase

| Academic year | Degrees awarded in chemistry <sup>a</sup> |         |         | Degrees awarded in chemical engineering |         |         |
|---------------|-------------------------------------------|---------|---------|-----------------------------------------|---------|---------|
|               | Bachelors                                 | Masters | Ph.D.'s | Bachelors                               | Masters | Ph.D.'s |
| 1967-68       | 10,847                                    | 2014    | 1757    | 3211                                    | 1156    | 367     |
| 1968-69       | 11,807                                    | 2070    | 1941    | 3557                                    | 1136    | 409     |
| 1969-70       | 11,617                                    | 2146    | 2208    | 3720                                    | 1045    | 438     |
| 1970-71       | 11,183                                    | 2284    | 2160    | 3615                                    | 1100    | 406     |
| 1971-72       | 10,721                                    | 2259    | 1971    | 3663                                    | 1154    | 394     |
| 1972-73       | 10,226                                    | 2230    | 1882    | 3636                                    | 1051    | 397     |
| 1973-74       | 10,525                                    | 2138    | 1828    | 3454                                    | 1045    | 400     |
| 1974-75       | 10,649                                    | 2006    | 1824    | 3142                                    | 990     | 346     |
| 1975-76       | 11,107                                    | 1796    | 1623    | 3203                                    | 1031    | 308     |
| 1976-77       | 11,322                                    | 1775    | 1571    | 3581                                    | 1086    | 291     |
| 1977-78       | 11,474                                    | 1892    | 1525    | 4615                                    | 1237    | 259     |

<sup>a</sup> Does not include biochemistry and geochemistry. Source: Department of Education's National Center for Education Statistics

### GRADUATE STUDENTS: Chemistry students increase moderately

| Thousands                   | 1978         | 1977         | 1976         | 1975         | 1974         |
|-----------------------------|--------------|--------------|--------------|--------------|--------------|
| <b>TOTAL</b>                |              |              |              |              |              |
| Physical sciences           | 25.0         | 25.3         | 25.3         | 24.8         | 24.7         |
| Chemistry                   | 14.8         | 14.7         | 14.5         | 14.1         | 13.8         |
| Physics                     | 9.5          | 9.8          | 9.9          | 9.9          | 10.2         |
| Engineering                 | 66.2         | 66.7         | 64.6         | 65.1         | 57.1         |
| Chemical                    | 5.4          | 5.3          | 5.2          | 5.0          | 4.7          |
| Metallurgical and materials | 2.5          | 2.5          | 2.4          | 2.4          | 2.3          |
| Petroleum                   | 0.5          | 0.4          | 0.4          | 0.3          | 0.3          |
| Biological sciences         | 42.8         | 43.1         | 41.7         | 41.1         | 38.1         |
| Biochemistry                | 3.9          | 3.8          | 3.7          | 3.7          | 3.7          |
| Other sciences              | 178.0        | 174.9        | 169.0        | 165.4        | 147.4        |
| <b>TOTAL</b>                | <b>312.0</b> | <b>310.0</b> | <b>300.6</b> | <b>296.4</b> | <b>267.3</b> |
| <b>FULL-TIME ONLY</b>       |              |              |              |              |              |
| Physical sciences           | 21.7         | 21.9         | 21.8         | 21.4         | 21.4         |
| Chemistry                   | 12.6         | 12.6         | 12.4         | 12.0         | 11.7         |
| Physics                     | 8.4          | 8.8          | 8.8          | 8.8          | 9.0          |
| Engineering                 | 37.1         | 36.8         | 36.4         | 37.1         | 33.7         |
| Chemical                    | 4.1          | 4.0          | 3.7          | 3.6          | 3.3          |
| Metallurgical and materials | 2.0          | 2.0          | 1.9          | 1.8          | 1.7          |
| Petroleum                   | 0.4          | 0.3          | 0.4          | 0.3          | 0.3          |
| Biological sciences         | 35.6         | 35.8         | 35.2         | 34.7         | 32.4         |
| Biochemistry                | 3.6          | 3.5          | 3.4          | 3.4          | 3.4          |
| Other sciences              | 123.2        | 123.9        | 121.5        | 118.4        | 108.4        |
| <b>TOTAL</b>                | <b>217.6</b> | <b>218.4</b> | <b>214.9</b> | <b>211.6</b> | <b>195.9</b> |

Note: Data for Ph.D.-granting institutions only. Source: National Science Foundation

# SCHOOLS SPENDING MOST ON R&D IN CHEMISTRY: Top 10 account for nearly a fourth

| \$ Thousands                            | Total spending     |           |           |                  | Federally financed spending |                  |                  |          |
|-----------------------------------------|--------------------|-----------|-----------|------------------|-----------------------------|------------------|------------------|----------|
|                                         | 1978               | 1977      | 1976      | 1975             | 1978                        | 1977             | 1976             | 1975     |
| 1 Massachusetts Inst. of Technology     | \$ 6,242           | \$ 4,735  | \$ 4,298  | \$ 3,740         | \$ 5,837                    | \$ 4,351         | \$ 3,887         | \$ 3,436 |
| 2 U of Wisconsin, Madison               | 5,149              | 5,136     | 4,702     | 5,033            | 2,933                       | 2,880            | 2,743            | 2,536    |
| 3 California Inst. of Technology        | 4,108 <sup>a</sup> | 5,143     | 3,860     | 3,234            | 3,712                       | 4,322            | 3,244            | 2,722    |
| 4 Harvard U                             | 3,905              | 2,958     | 3,187     | 2,850            | 3,396                       | 2,566            | 2,916            | 2,610    |
| 5 Carnegie-Mellon U                     | 3,628              | 4,425     | 4,231     | 3,729            | 1,542                       | 1,079            | 1,552            | 1,294    |
| 6 U of California, San Diego            | 3,611              | 3,344     | 3,176     | 2,904            | 3,293                       | 3,064            | 2,922            | 2,671    |
| 7 Stanford U                            | 3,549 <sup>a</sup> | 2,659     | 2,238     | 1,664            | 3,266                       | 2,581            | 2,197            | 1,626    |
| 8 Cornell U                             | 3,423              | 3,047     | 2,702     | 2,548            | 3,137                       | 2,888            | 2,547            | 2,399    |
| 9 Columbia U, main division             | 3,321              | 2,975     | 2,562     | 2,285            | 2,854                       | 2,747            | 2,186            | 1,993    |
| 10 Texas A&M U                          | 3,261              | 3,894     | 4,132     | 2,153            | 2,243                       | 2,205            | 2,464            | 1,317    |
| Total first 10 institutions             | 40,397             | 38,316    | 35,088    | 30,140           | 32,213                      | 28,683           | 26,658           | 22,604   |
| 11 U of California, Los Angeles         | 3,236              | 2,563     | 2,355     | 2,106            | 3,052                       | 2,408            | 2,265            | 1,947    |
| 12 U of Illinois, Urbana                | 3,211              | 2,438     | 2,068     | 1,960            | 2,426                       | 2,045            | 1,832            | 1,722    |
| 13 U of Chicago                         | 3,113 <sup>a</sup> | 2,789     | 2,473     | 2,596            | 2,803                       | 2,684            | 2,348            | 2,362    |
| 14 U of Texas, Austin                   | 3,057              | 2,361     | 1,954     | 1,866            | 1,931                       | 1,286            | 918              | 758      |
| 15 U of California, Berkeley            | 3,046              | 3,090     | 2,948     | 2,674            | 2,758                       | 2,742            | 2,629            | 2,504    |
| 16 Purdue U, all campuses               | 2,857              | 2,545     | 2,171     | 1,818            | 2,500                       | 2,170            | 1,883            | 1,578    |
| 17 Georgia Inst. of Technology          | 2,784              | 2,013     | 1,590     | 990              | 1,551                       | 1,075            | 803              | 531      |
| 18 U of Utah                            | 2,754              | 7,149     | 1,868     | 1,394            | 1,909                       | 5,636            | 1,633            | 1,283    |
| 19 Wayne State U                        | 2,740              | 1,280     | 1,028     | 892              | 1,928                       | 1,172            | 950              | 861      |
| 20 U of Notre Dame                      | 2,475              | 2,560     | 1,992     | 1,597            | 2,389                       | 2,461            | 1,873            | 1,531    |
| Total first 20 institutions             | 69,670             | 67,104    | 55,535    | 48,033           | 55,458                      | 52,362           | 43,792           | 37,681   |
| 21 Indiana U, Bloomington               | 2,199              | 1,601     | 1,535     | 1,403            | 1,953                       | 1,481            | 1,357            | 1,240    |
| 22 U of Rochester                       | 2,100              | 1,987     | 1,537     | 1,292            | 1,695                       | 1,519            | 1,221            | 964      |
| 23 U of Massachusetts, Amherst          | 2,036              | 1,922     | 1,619     | 1,162            | 1,633                       | 1,308            | 1,131            | 846      |
| 24 U of Maryland, College Park          | 1,975              | 1,389     | 1,568     | 1,540            | 1,690                       | 959              | 1,125            | 1,243    |
| 25 Pennsylvania State U                 | 1,904              | 1,452     | 1,324     | 1,155            | 1,590                       | 1,309            | 1,150            | 967      |
| 26 Northwestern U                       | 1,854              | 1,250     | 1,231     | 1,287            | 1,681                       | 1,068            | 1,043            | 1,128    |
| 27 U of Minnesota                       | 1,803              | 1,867     | 1,443     | 1,256            | 1,415                       | 1,279            | 1,288            | 1,067    |
| 28 U of Arkansas                        | 1,765              | 249       | 239       | 265              | 295                         | 217              | 198              | 235      |
| 29 U of Pennsylvania                    | 1,761              | 973       | 1,037     | 870              | 1,356                       | 762              | 785              | 614      |
| 30 Ohio State U                         | 1,740              | 2,015     | 1,687     | 1,599            | 1,493                       | 1,738            | 1,610            | 1,377    |
| Total first 30 institutions             | 88,809             | 81,609    | 68,755    | 59,862           | 70,259                      | 64,002           | 54,700           | 47,362   |
| 31 U of Pittsburgh                      | 1,709              | 1,542     | 1,129     | 1,120            | 1,201                       | 1,328            | 1,037            | 1,017    |
| 32 U of Southern California             | 1,676              | 764       | 719       | 727              | 1,381                       | 722              | 664              | 662      |
| 33 Princeton U                          | 1,660              | 1,508     | 1,628     | 1,494            | 1,271                       | 1,113            | 1,068            | 1,050    |
| 34 SUNY, Stony Brook                    | 1,637              | 1,201     | 1,009     | 73               | 1,281                       | 1,050            | 907              | 73       |
| 35 Florida State U                      | 1,490              | 1,470     | 1,475     | 884              | 777                         | 727 <sup>a</sup> | 786 <sup>a</sup> | 587      |
| 36 Yale U                               | 1,444              | 1,532     | 1,346     | 1,653            | 1,379                       | 1,455            | 1,329            | 1,558    |
| 37 U of California, Irvine              | 1,435              | 1,376     | 1,119     | 856              | 1,372                       | 1,297            | 1,062            | 814      |
| 38 Iowa State U of Sci. & Tech.         | 1,434              | 736       | 640       | 557              | 589                         | 269              | 184              | 176      |
| 39 U of North Carolina, Chapel Hill     | 1,413              | 1,471     | 1,422     | 1,206            | 1,398                       | 1,448            | 1,386            | 1,146    |
| 40 Colorado State U                     | 1,398              | 1,100     | 881       | 667              | 1,193                       | 853              | 766              | 568      |
| Total first 40 institutions             | 104,105            | 94,309    | 80,123    | 69,099           | 82,101                      | 74,264           | 63,891           | 55,013   |
| 41 U of Arizona                         | 1,390              | 1,512     | 1,361     | 1,339            | 881                         | 1,145            | 1,017            | 1,087    |
| 42 SUNY College of Env. Sci. & Forestry | 1,364              | 832       | 802       | 758              | 524                         | 601              | 481              | 381      |
| 43 U of Florida                         | 1,265              | 769       | 631       | 569              | 1,077                       | 686              | 575              | 522      |
| 44 U of Georgia                         | 1,265              | 1,311     | 1,443     | 694              | 642                         | 711              | 825              | 586      |
| 45 Michigan State U                     | 1,262              | 1,266     | 1,221     | 952 <sup>a</sup> | 878                         | 1,063            | 842              | 878      |
| 46 Louisiana State U system             | 1,204              | 927       | 825       | 753              | 635                         | 661              | 555              | 514      |
| 47 Case Western Reserve U               | 1,190              | 1,199     | 1,250     | 1,249            | 940                         | 973              | 979              | 1,040    |
| 48 U of Houston                         | 1,171              | 1,025     | 1,353     | 574              | 607                         | 537              | 709              | 291      |
| 49 U of Michigan                        | 1,171              | 851       | 1,247     | 826              | 982                         | 604              | 841              | 635      |
| 50 Johns Hopkins U                      | 1,160              | 1,160     | 1,107     | 1,092            | 1,084                       | 1,102            | 1,048            | 1,001    |
| TOTAL FIRST 50 INSTITUTIONS             | \$116,547          | \$105,161 | \$91,363  | \$77,905         | \$90,351                    | \$82,347         | \$71,763         | \$61,948 |
| NATIONAL TOTAL                          | \$174,775          | \$156,707 | \$133,715 | \$115,063        | \$133,113                   | \$120,561        | \$103,166        | \$88,690 |

Note: Data for fiscal years at Ph.D.-granting institutions only. <sup>a</sup> Estimate. Source: National Science Foundation

# SCHOOLS WITH MOST SCIENTIFIC EMPLOYEES: Physical scientists declined in 1979

|                                          | Physical scientists |                  |                            |                  | All scientists and engineers |                    |                            |                    |
|------------------------------------------|---------------------|------------------|----------------------------|------------------|------------------------------|--------------------|----------------------------|--------------------|
|                                          | Total               |                  | Total full-time equivalent |                  | Total                        |                    | Total full-time equivalent |                    |
|                                          | 1979                | 1978             | 1979                       | 1978             | 1979                         | 1978               | 1979                       | 1978               |
| 1 Massachusetts Inst. of Technology      | 476                 | 510              | 452                        | 491              | 2,449                        | 2,425              | 2,247                      | 2,237              |
| 2 U of Texas, Austin                     | 398                 | 433              | 391                        | 424              | 1,933                        | 1,874              | 1,792                      | 1,774              |
| 3 U of California, Los Angeles           | 364                 | 347              | 240                        | 331 <sup>a</sup> | 2,451                        | 2,413              | 1,920                      | 2,182 <sup>a</sup> |
| 4 U of California, Berkeley              | 349                 | 318              | 261                        | 302 <sup>a</sup> | 1,967                        | 1,909              | 1,620                      | 1,770 <sup>a</sup> |
| 5 U of Illinois, Urbana                  | 293                 | 295              | 147                        | 277              | 2,232                        | 2,310              | 1,088                      | 2,163              |
| 6 U of Maryland, College Park            | 293                 | 294              | 268                        | 279              | 1,508                        | 1,447              | 1,335                      | 1,322              |
| 7 U of Wisconsin, Madison                | 289                 | 278              | 277                        | 264              | 3,758                        | 3,691              | 3,497                      | 3,334              |
| 8 Harvard U                              | 268                 | 252              | 260                        | 243              | 5,414                        | 5,135              | 4,779                      | 4,261              |
| 9 U of Michigan                          | 262                 | 286              | 251                        | 269              | 3,535                        | 3,405              | 3,080                      | 3,009              |
| 10 U of Arizona                          | 235                 | 257              | 228                        | 248              | 1,553                        | 1,661              | 1,463                      | 1,569              |
| Total first 10 institutions <sup>b</sup> | 3,227               | 3,270            | 2,775                      | 3,128            | 26,800                       | 26,350             | 22,821                     | 23,621             |
| 11 Cornell U                             | 227                 | 218              | 203                        | 213              | 2,703                        | 2,723              | 2,577 <sup>a</sup>         | 2,643              |
| 12 U of Houston                          | 224                 | 103              | 192 <sup>a</sup>           | 99               | 892                          | 524                | 803 <sup>a</sup>           | 472                |
| 13 Stanford U                            | 216                 | 193              | 200                        | 179              | 1,973                        | 1,845              | 1,795                      | 1,723              |
| 14 Purdue U, all campuses                | 215                 | 216              | 205                        | 203              | 1,993                        | 1,797              | 1,832                      | 1,690              |
| 15 U of Colorado                         | 211 <sup>a</sup>    | 209              | 209 <sup>a</sup>           | 208              | 1,340                        | 1,330              | 1,291                      | 1,281              |
| 16 U of Chicago                          | 207 <sup>a</sup>    | 207              | 201 <sup>a</sup>           | 201              | 1,357                        | 1,357              | 1,329                      | 1,329              |
| 17 Ohio State U                          | 199                 | 181              | 188                        | 171              | 3,541                        | 3,512              | 2,981                      | 2,984              |
| 18 Rutgers U                             | 195                 | 170              | 187                        | 162 <sup>a</sup> | 1,628                        | 1,554              | 1,532                      | 1,452 <sup>a</sup> |
| 19 Pennsylvania State U                  | 193                 | 218              | 186                        | 206              | 2,200                        | 2,118              | 2,100                      | 1,985              |
| 20 U of Rochester                        | 191                 | 192              | 178                        | 181              | 1,093                        | 1,063              | 1,044                      | 1,021              |
| Total first 20 institutions <sup>b</sup> | 5,305               | 5,177            | 4,724                      | 4,951            | 45,520                       | 44,173             | 40,105                     | 40,201             |
| 21 Michigan State U                      | 183                 | 182              | 180                        | 179              | 1,763                        | 1,748              | 1,687                      | 1,674              |
| 22 U of Pittsburgh                       | 182                 | 153 <sup>a</sup> | 173                        | 146 <sup>a</sup> | 1,918                        | 1,904 <sup>a</sup> | 1,749                      | 1,708 <sup>a</sup> |
| 23 U of Minnesota                        | 174                 | 179              | 165                        | 169              | 3,581                        | 3,471              | 3,034                      | 3,146              |
| 24 U of California, San Diego            | 173                 | 178              | 163                        | 170 <sup>a</sup> | 1,057                        | 1,069              | 1,005                      | 993 <sup>a</sup>   |
| 25 U of Utah                             | 159                 | 154              | 145                        | 140              | 1,678                        | 1,639              | 1,486                      | 1,426              |
| 26 Yale U                                | 158                 | 131              | 148                        | 127              | 2,060                        | 1,911              | 1,895                      | 1,755 <sup>a</sup> |
| 27 Princeton U                           | 151                 | 167              | 149                        | 162              | 596                          | 670                | 577                        | 630                |
| 28 Columbia U, main division             | 150                 | 164              | 150 <sup>a</sup>           | 157              | 2,075                        | 2,028              | 1,761 <sup>a</sup>         | 1,721              |
| 29 SUNY, Stony Brook                     | 149                 | 134              | 142                        | 131              | 858                          | 764                | 781                        | 715                |
| 30 U of Washington                       | 148                 | 139              | 141                        | 132              | 2,545                        | 2,586              | 2,292                      | 2,333              |
| Total first 30 institutions <sup>b</sup> | 6,032               | 6,758            | 6,280                      | 6,464            | 63,651                       | 61,963             | 56,372                     | 56,302             |
| 31 Carnegie-Mellon U                     | 139                 | 133              | 135                        | 126 <sup>a</sup> | 574                          | 566                | 536                        | 528 <sup>a</sup>   |
| 32 Louisiana State U system              | 137                 | 100              | 135                        | 99               | 3,011                        | 2,535              | 2,558                      | 2,102              |
| 33 U of Southern California              | 128                 | 155              | 121                        | 147 <sup>a</sup> | 1,802                        | 1,910              | 1,578                      | 1,624 <sup>a</sup> |
| 34 Georgia Inst. of Technology           | 126                 | 175              | 117                        | 168              | 868                          | 1,089              | 818                        | 1,024              |
| 35 U of Tennessee, Knoxville             | 124                 | 122              | 109                        | 108              | 937                          | 843                | 855                        | 757                |
| 36 U of Kansas                           | 122 <sup>a</sup>    | 105 <sup>a</sup> | 115 <sup>a</sup>           | 101 <sup>a</sup> | 1,442                        | 1,415 <sup>a</sup> | 1,323                      | 1,295 <sup>a</sup> |
| 37 U of Delaware                         | 120                 | 98 <sup>a</sup>  | 108                        | 95 <sup>a</sup>  | 559                          | 525 <sup>a</sup>   | 531                        | 504 <sup>a</sup>   |
| 38 U of Massachusetts, Amherst           | 120                 | 118              | 123                        | 118              | 857                          | 848                | 832                        | 823                |
| 39 Indiana U, Bloomington                | 111                 | 112              | 108                        | 107              | 486                          | 474                | 446                        | 442                |
| 40 SUNY Buffalo                          | 110                 | 101 <sup>a</sup> | 107                        | 101 <sup>a</sup> | 783                          | 1,200 <sup>a</sup> | 699                        | 1,093 <sup>a</sup> |
| Total first 40 institutions <sup>b</sup> | 8,169               | 7,977            | 7,458                      | 7,634            | 74,970                       | 73,371             | 66,546                     | 66,494             |
| 41 Northwestern U                        | 109                 | 122              | 107                        | 122              | 843                          | 968                | 775                        | 902                |
| 42 Duke U                                | 106                 | 103              | 81                         | 83               | 2,067                        | 1,825              | 1,705                      | 1,442              |
| 43 U of Notre Dame                       | 105                 | 98               | 103                        | 94               | 348                          | 346                | 338                        | 333                |
| 44 Oregon State U                        | 100                 | 102              | 92                         | 99               | 1,139                        | 1,148              | 1,072                      | 1,113              |
| 45 New York U                            | 100                 | 102              | 88                         | 91               | 2,007                        | 1,969              | 1,520                      | 1,511              |
| 46 Texas A&M U                           | 99                  | 97               | 99                         | 97               | 2,138                        | 2,072              | 2,138                      | 2,072              |
| 47 U of Kentucky, all campuses           | 98                  | 124 <sup>a</sup> | 91                         | 118              | 1,782                        | 1,394              | 1,648                      | 1,285              |
| 48 Johns Hopkins U                       | 95                  | 85               | 94                         | 83               | 1,874                        | 2,319              | 1,755                      | 2,086              |
| 49 U of Iowa                             | 94                  | 70               | 92                         | 70               | 1,741                        | 1,477              | 1,622                      | 1,398              |
| 50 Florida State U                       | 93                  | 92               | 92                         | 91               | 532                          | 500                | 507                        | 480                |
| TOTAL FIRST 50 INSTITUTIONS <sup>b</sup> | 9,168               | 8,972            | 8,377                      | 8,582            | 89,441                       | 87,389             | 79,626                     | 79,116             |
| NATIONAL TOTAL                           | 18,364              | 18,238           | 16,922                     | 17,398           | 207,635                      | 199,920            | 184,253                    | 180,726            |

Note: Data as of January of each year for Ph.D.-granting institutions only. <sup>a</sup> Estimate. <sup>b</sup> Ranked according to total physical scientists in 1979. Source: National Science Foundation

# SCHOOLS WITH THE MOST GRADUATE STUDENTS: State universities rank high

|                                     | Physical science graduate students |           |           | All graduate students |           |           |
|-------------------------------------|------------------------------------|-----------|-----------|-----------------------|-----------|-----------|
|                                     | Total                              | Full-time | Part-time | Total                 | Full-time | Part-time |
| 1 U of California, Berkeley         | 639                                | 627       | 12        | 5,542                 | 5,322     | 220       |
| 2 U of Illinois, Urbana             | 584                                | 581       | 3         | 4,130                 | 3,893     | 237       |
| 3 U of Maryland, College Park       | 460                                | 279       | 181       | 2,886                 | 1,353     | 1,533     |
| 4 Massachusetts Inst. of Technology | 459                                | 459       | 0         | 3,664                 | 3,664     | 0         |
| 5 U of Texas, Austin                | 456                                | 445       | 11        | 3,596                 | 3,008     | 588       |
| 6 U of Wisconsin, Madison           | 423                                | 423       | 0         | 5,130                 | 4,514     | 616       |
| 7 U of California, Los Angeles      | 418                                | 411       | 7         | 4,037                 | 3,891     | 146       |
| 8 Purdue U                          | 411                                | 378       | 33        | 3,582                 | 2,982     | 600       |
| 9 U of California, San Diego        | 371                                | 350       | 21        | 1,127                 | 1,067     | 60        |
| 10 U of Arizona                     | 365                                | 344       | 21        | 2,890                 | 2,244     | 646       |
| Total first 10 institutions*        | 4,586                              | 4,297     | 289       | 36,584                | 31,938    | 4,646     |
| 11 Ohio State University            | 354                                | 349       | 5         | 4,622                 | 3,739     | 883       |
| 12 Cornell U                        | 348                                | 348       | 0         | 2,669                 | 2,655     | 14        |
| 13 Rutgers U                        | 319                                | 162       | 157       | 4,249                 | 1,721     | 2,528     |
| 14 Stanford U                       | 318                                | 317       | 1         | 3,318                 | 3,071     | 247       |
| 15 California Inst. of Technology   | 297                                | 297       | 0         | 856                   | 847       | 9         |
| 16 Harvard U                        | 296                                | 296       | 0         | 2,308                 | 2,198     | 110       |
| 17 Michigan State U                 | 273                                | 260       | 13        | 3,339                 | 2,904     | 435       |
| 18 Texas A&M U                      | 272                                | 236       | 36        | 3,063                 | 2,442     | 621       |
| 19 Iowa State U of Sci. & Tech.     | 269                                | 253       | 16        | 2,299                 | 1,731     | 568       |
| 20 Pennsylvania State U             | 268                                | 249       | 19        | 3,256                 | 2,349     | 907       |
| Total first 20 institutions*        | 7,600                              | 7,064     | 536       | 66,563                | 55,595    | 10,968    |
| 21 U of Washington                  | 265                                | 232       | 33        | 4,370                 | 3,378     | 992       |
| 22 Indiana U, Bloomington           | 263                                | 262       | 1         | 1,824                 | 1,486     | 338       |
| 23 Columbia U, main division        | 255                                | 255       | 0         | 2,689                 | 2,086     | 603       |
| 24 U of Colorado                    | 253                                | 248       | 5         | 3,311                 | 2,482     | 829       |
| 25 U of Chicago                     | 252                                | 251       | 1         | 1,493                 | 1,415     | 78        |
| 26 U of Minnesota                   | 249                                | 243       | 6         | 4,863                 | 4,099     | 764       |
| 27 U of Michigan                    | 233                                | 216       | 17        | 4,608                 | 4,078     | 530       |
| 28 U of Pittsburgh                  | 227                                | 205       | 22        | 2,936                 | 1,572     | 1,364     |
| 29 SUNY, Stony Brook                | 225                                | 208       | 17        | 2,128                 | 1,475     | 653       |
| 30 George Washington U              | 221                                | 47        | 174       | 2,923                 | 702       | 2,221     |
| Total first 30 institutions*        | 10,043                             | 9,231     | 812       | 97,708                | 78,368    | 19,340    |
| 31 U of Pennsylvania                | 208                                | 196       | 12        | 2,067                 | 1,624     | 443       |
| 32 U of Rochester                   | 208                                | 196       | 12        | 905                   | 780       | 125       |
| 33 Northeastern U                   | 208                                | 100       | 108       | 3,050                 | 672       | 2,378     |
| 34 Princeton U                      | 206                                | 206       | 0         | 1,006                 | 1,006     | 0         |
| 35 U of North Carolina, Chapel Hill | 196                                | 193       | 3         | 2,359                 | 2,138     | 221       |
| 36 U of Massachusetts, Amherst      | 196                                | 171       | 25        | 1,912                 | 1,669     | 243       |
| 37 New York U                       | 195                                | 137       | 58        | 4,239                 | 1,630     | 2,609     |
| 38 Yale U                           | 193                                | 193       | 0         | 1,522                 | 1,495     | 27        |
| 39 CUNY Graduate School & U Center  | 189                                | 188       | 1         | 1,607                 | 1,536     | 71        |
| 40 U of Akron                       | 189                                | 115       | 74        | 895                   | 417       | 478       |
| Total first 40 institutions*        | 12,031                             | 10,926    | 1,105     | 117,270               | 91,335    | 25,935    |
| 41 U of Florida                     | 182                                | 173       | 9         | 2,215                 | 1,963     | 252       |
| 42 U of Cincinnati                  | 174                                | 162       | 12        | 2,263                 | 1,369     | 894       |
| 43 Northwestern U                   | 173                                | 166       | 7         | 1,321                 | 1,144     | 177       |
| 44 SUNY, Buffalo                    | 171                                | 161       | 10        | 1,994                 | 1,386     | 608       |
| 45 U of California, Santa Barbara   | 167                                | 167       | 0         | 1,039                 | 1,002     | 37        |
| 46 U of Utah                        | 163                                | 151       | 12        | 1,886                 | 1,468     | 418       |
| 47 Wayne State U                    | 159                                | 126       | 33        | 2,086                 | 1,313     | 773       |
| 48 Polytechnic Inst. of New York    | 152                                | 53        | 99        | 2,198                 | 354       | 1,844     |
| 49 U of Virginia                    | 151                                | 135       | 16        | 1,391                 | 1,158     | 233       |
| 50 U of Oregon                      | 150                                | 148       | 4         | 787                   | 702       | 85        |
| TOTAL FIRST 50 INSTITUTIONS*        | 13,673                             | 12,366    | 1,307     | 134,450               | 103,194   | 31,256    |
| NATIONAL TOTAL                      | 25,037                             | 21,651    | 3,386     | 311,982               | 217,588   | 94,394    |

Note: Data for 1978 for Ph.D.-granting institutions only. \* Ranked according to total physical science graduate students. Source: National Science Foundation